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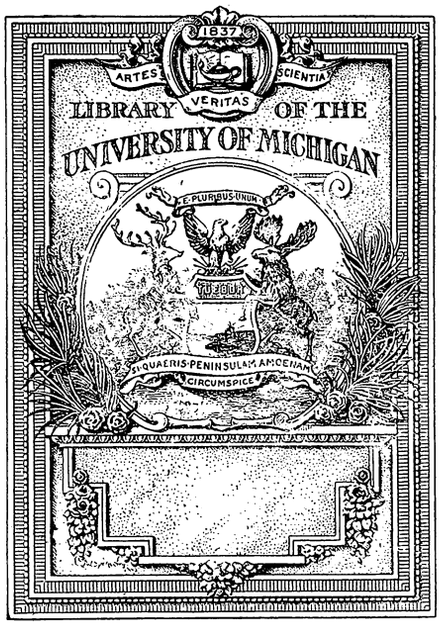

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THE ELECTRICIAN:

A WEEKLY JOURNAL OF

THEORETICAL AND APPLIED ELECTRICITY AND CHEMICAL PHYSICS.

No. 1.—Vol. IV. SATURDAY, NOVEMBER 22, 1879. Price 4d.

SLIP

Personal.—Mr. J. Munro, C.E., has joined the editorial staff of *The Electrician*.

Kentucky.—Mammoth Cave is to be illuminated by means of the electric light.

Edison.—There is no truth in the facetious report that Mr. Edison has become a gas engineer.

Dr. Siemens.—The *Inventor's Record* for November 1 contains a portrait and a biographical sketch of the life of Dr. C. W. Siemens, F.R.S.

Electric Light.—The electric light is being introduced into several of the Lake Superior iron mines. We hope the the introduction will be mutually beneficial.

The Ronalds Library.—The contract for binding the Ronalds Library has been closed, and the work is now being rapidly pushed forward under the supervision of Mr. A. J. Frost.

City Guilds Institute.—The classes instituted by the City Guilds Institute, which meet at the Cowper-street schools, now number between ninety and one hundred members.

Liverpool.—The Town Council of Liverpool recently resolved to expend £600 in electric lighting, the lights to be placed on the roof of St. George's Hall and on the Wellington monument.

Society of Telegraph Engineers.—The next meeting of this society is to be held on Nov. 26, and the subject is a "Note on the Use of Condensers," by M. Felix Garay, a foreign member.

Sir W. Fothergill Cooke.—The biography of Sir W. F. Cooke, to appear in the current number of the *Journal of the Society of Telegraph Engineers*, is, we believe, by Mr. Latimer Clark, C.E.

Clerk Maxwell's Papers.—The papers of the late Professor Clerk Maxwell will be placed in the hands of Professor Stokes, one of his executors, in order that they may be catalogued or published.

Where Ignorance is Bliss, &c.—The young lady who, on observing the wavy signals arriving on the Siphon Recorder per the Atlantic cable, inquired if they got sea-sick coming over was not a profound electrician.

Something New.—A new use for telegraph poles is reported from the land of the Celestials, where the Mandarins embellish them with the heads of decapitated highway robbers as a terror to the evil-disposed.

Cable Ships.—The ss. Scotia has passed Malta on her way out to Zanzibar with the last section of the Cape cable. The ss. Calabria has arrived at Malta on her return from successfully laying one section of the Cape cable.

Galvani.—The newly-erected statue of Galvani, in his native city of Bologna, is of marble, and represents the illustrious electrician in the act of touching with two different metals the lumbar nerves of a skinned frog.

Sydney Exhibition.—The show of electro-plate at the Sydney International Exhibition is said to be very fine. The choicest exhibit is that of Christofle et Cie, of Paris, but England and American manufacturers contribute first-rate collections.

Literary.—We understand that Mr. Conrad Cooke is the author of the articles, "Lighting by Electricity," now appearin *Engineering*, and that when complete the papers will be republished in book form. Better, we think, have issued the book at once, except, perhaps, for the expense.

The Faraday.—The shore end of the new French cable was successfully laid on Cape Cod on Sunday afternoon. Signals were exchanged through it with the Faraday, which, on the 17th instant, proceeded to the deep sea cable buoyed in the offing, in order to make the necessary splice.

New Zealand Telegraphy.—The number of telegrams forwarded in New Zealand in the three months ending June 30 this year was 355,331, against 334,303 in the corresponding period of 1878. The cash receipts in the three months ending June 30 this year were £18,946, as compared with £19,037 in the corresponding period of 1878.

Chair of Experimental Physics at Cambridge.—Lord Rayleigh's election to the chair of experimental physics, vacant by the death of Prof. Clerk Maxwell, is strongly recommended by a memorial now in circulation. We have not heard, however, whether his lordship has consented to become a candidate or not. There can be no doubt as to his fitness for the post.

Direct United States Cable Company.—This company is showing an earnest desire to furnish the telegraphing public with every facility for transacting business. A new branch receiving station has been opened at the General Offices, 52, Old Broad-street, E.C. A new station has been opened at Boston, and an additional branch office at New

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York. We trust these energetic measures will meet with a due reward of success.

GREAT NORTHERN TELEGRAPH COMPANY.—The number of telegrams forwarded by the Great Northern Telegraph Company, in the nine months ending September 30 this year, was 647,833, as compared with 645,806 in the corresponding period of 1878. The revenue acquired in the first nine months of this year was £152,175, as compared with £152,641, in the corresponding period of 1878.

ROYAL SOCIETY.—At the Royal Society, on Nov. 20, Dr. De la Rue and Dr. Hugo Müller read a paper giving an account of their experimental researches on the electric discharge with the chloride of silver battery, and Lord Elphinstone and Mr. C. W. Vincent presented a preliminary note on magnetic circuits in dynamo and magneto-electric machines. We hope to give abstracts of these papers in our next issue.

CEYLON.—At the recent meeting of the Legislative Council, the Governor announced that the Government had received notice from the Indian Government that it must resign the working of the Ceylon telegraphs. At present the Ceylon Government pays 20,000 rupees annually to meet losses incurred, but will not guarantee an unlimited sum as demanded. The transfer will probably be made in July of next year.

TELEPHONE EXCHANGES.—We understand that the telephone company is very busy in arranging exchanges in various places, and on Nov. 8th, the manager of the Edison company writes to *The Times* that the Edison system has been successful over fifteen miles of wire. Go ahead! We hear that the latter company desires to monopolise the tobacco interest, and establish telephonic communication between the merchants and their clients.

MELTING POINTS OF REFRACTORY METALS.—In connection with contemporary experiments on electric lighting by the incandescence of refractory metals, it is interesting to note the following melting points, as determined by M. Violle:—Iridium, 1,950° centigrade; platinum, 1,775°; palladium, 1,500°; copper, 1,054°; gold, 1,035°; silver, 954°. The specific heat of iridium, like that of platinum, regularly increases with the temperature. The specific heat of gold varies little up to 600°, and then increases sensibly on approaching the melting point.

CORNWALL.—Edison's telephone has been tried at the Wheal Uny mine for communication between the office on the pit head and the adit level 26 fathoms below the surface. Orders were freely given and heard in spite of a good deal of noise from stamping and splashing of water. The verdict was that while the Edison instrument gave louder sounds than the Bell telephone, it did not reproduce the clang-tint of the voice so perfectly. There is undoubtedly a slightly Punchinellian tone in the utterances of the Edison telephone, but from our own experience we should say that a very little practice would enable any one to recognise the voice of the distant speaker at once.

SIR JAMES ANDERSON.—Our attention has been called to a small but ably written pamphlet, entitled "Living Lives," and published by Provost and Co., 40, Tavistock-street, Covent Garden, in which, among short sketches of the chater and work of Mr. Gladstone, Thomas Carlyle, and others, there is one of Captain Sir James Anderson. The writer says of Sir James:—"His public and private life has ever been eminently honourable and useful; yet it is a loss to the country in a more national sense that his long-varied and peculiarly practical experience, both as a seaman and a man of business, and his clear, sound, and steadfast ability, and common sense, his increasing vigour, and his honesty of act and purpose, are not more directly devoted to her service."

AMERICAN LABOUR-SAVING NOTION.—The big water-works tunnel, at Columbus, Ohio, is nearly completed. By its use it is intended to do without river water altogether, as it is expected that enough will filter into the tunnel to supply the city. To guard against emergencies—which, however, are not anticipated—a tower is to be constructed at the western extremity of the tunnel, with a pipe leading to the river. A valve in the bottom of the tower will admit or shut out the water from the river. This valve will be operated by electricity, carried by wires from the works. The apparatus will be so arranged as to enable the operator to open the valve to any number of degrees he may desire. This will save the trouble and time of walking out to the tower to turn the water in from the river.

SOUTH AUSTRALIAN TELEGRAPHY.—The South Australian portion of a telegraph line to Western Australia was completed to Eucla July 16, 1877. Great difficulties were experienced in erecting the section between Fowler's Bay and Eucla, owing to the extreme scarcity of feed and water, and the long distances over which materials had to be carted, but these obstacles were effectually overcome, and the line completed in a thoroughly substantial manner. The Western Australian line is 800 miles long, and the South Australian portion, including the line from Adelaide, about 971 miles long. During 1877, 15 new telegraph stations were opened in South Australia. The number of messages transmitted inland in 1877 was 408,953, and international 12,479, producing £20,770 for local lines, £6,374 for intercolonial lines, and £14,112 for proportion of international line, a total of £41,858.

FISH KILLED BY ELECTRICITY.—A correspondent of *Land and Water* says:—A curious incident of the whole of the occupants of a small fish-pond being destroyed by a flash of lightning, is reported from Seck, Grand Duchy of Nassau. The *Nassauer Bote* states that during a very heavy thunder and hail storm at night time, a flash of lightning struck a small pond, well stocked with various kinds of fish, the property of the pastor of the parish. The following morning the whole of the fish were discovered dead upon the surface of the water. They had all the appearance of having been half boiled, and crumbled to pieces at the least touch, just as is the case with fish after being boiled. Neither any external or internal injury could be observed, the scales being intact and the swimming bladder filled and well preserved. The water in the pond was still muddy and dull the morning after the storm, as if the lightning had only then struck it.

THE WESTERN UNION TELEGRAPH.—The annual report of the President of the Western Union Telegraph, for the year ending June 30, 1879, contains a statement showing the mileage of lines and wires, the number of offices, and the traffic of the company for each of the past fourteen years. In 1866 the company owned 37,380 miles of line with 75,680 miles of wire, and had 2,250 offices. The number of messages sent is not given, but would appear to have been about 5,000,000. The increase in traffic year by year has been much more rapid than in the amount of wire or the number of offices. Last year the company had 82,978 miles of line, 211,566 miles of wire, 8,534 offices, and sent upwards of 25,000,000 messages, on which the charges were nearly 11,000,000 dollars, and the profits, 4,800,000 dollars. The

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capital stock of the company is, in round numbers, 41,000,000 dollars. The amount of new line under construction during the present year is 17,428 miles, in addition to which 1,801 miles of line have been renewed.

Codes.—On the 11th October the following notice was published in our columns with respect to Dr. Ager's code of 100,000 words:—"We have to announce that a list of 100,000 code words compiled from the several languages sanctioned by the London Telegraph Convention, is in the Press, and will shortly be issued. The words are arranged in single alphabetical order, and thus the inconvenience of searching through eight languages in the event of a telegraphic error, will be obviated. The work will be issued by Dr. Ager, but the Telegraph Companies agree to accept the words, subject to a notice to him of any words that may from time to time be discovered to be unsuitable, he in turn stipulating to communicate such notice to all purchasers of the code. It is hoped that by these means a standard code will eventually be compiled. A part of the edition will be printed on one side only, so as to afford facilities to merchants wishing to adapt their codes to the rules of the late convention without the expense of a reprint."—At that date we understand that Dr. Ager had promised to the different companies that he would submit proofs of his code for their revision. Two proofs only of six pages each have been forwarded, and, as no others have come to hand prior to the publication of the work, the companies naturally can have no more to say in favour of Dr. Ager's code than of any other. The companies will, of course, accept all words within the terms of the Convention.

Division of Electric Light.—Referring to the division of the electric light, the *Mining and Scientific Press* says:—"We give the result of experiments, of which we were an eye-witness, at the *atelier* of Messrs. Molera and Cebrian, in this city. The light used by them was a 4,000-candle electric light, enclosed in a chamber, on one side of which was a 24-inch Fresnel lens, from which the light is projected in parallel lines. The whole or any number of these lines or rays of light may be collected on a mirror or reflecting surface of any kind, and distributed in any greater or less intensity through secondary lenses without additional loss. In the experiment hardly one-half of the main light was collected, but it was divided into 16 separate lights, equal to 80 candles each. The secondary lenses were of small size, and situated in the ceiling, the light being thrown down. The quality of the light was equal to pure diffused daylight—in fact, several hundred shades of silk, arranged upon cards and placed side by side, could be distinguished as readily as by sunlight. Had it not been for the loss of light, occasioned by the size of the reflecting mirrors, we believe the light could have been subdivided to its fullest extent and into at least 50 separate lights. The whole light from the main lamp can be divided and subdivided, and distributed down to a single ray even at pleasure. The dispersing lenses and reflectors are arranged inside the building so as to illuminate every part without any obscure corners. In the open air the rays of light thrown upon objects over a mile away in the darkness of night brought them into view with startling distinctness."

Edisonia.—We hear that Edison claims the Blake microphone transmitter now used by the Bell Telephone Company as his *Inertia Telephone*, one of the early forms of his carbon telephone. In patent No. 2,909, dated July 30, 1877, Mr. Edison writes, "In one form of my apparatus the sound passes into a resonance box having one, two, or more tympans at its sides, that are vibrated thereby, the tension of these being various, so as to respond to different sound waves, and the electric connections pass through all to one line or circuit, in which is a battery and the distant receiving instrument. Circuit contact points are provided at one or both surfaces of the tympan or tympans; the tympans are of parchment, foil, mica, sheet metal, or similar material. I find platinum foil, or mica to respond advantageously when the waves from the mouth are made to pass through a slot resembling the larynx, when placed within the resonant tube. The contact points or surfaces are sometimes metallic, but plumbago, or similar semi-conducting material, into which the tympan is brought more or less intermittently into contact, or a point or pin thereon, serves to lessen or increase the electricity passing at the point." This is probably the passage on which the claim is based. Read by the light of later accomplished facts these early patents of Mr. Edison are very interesting. In them we can trace the first germs of his later inventions. Blake's microphone transmitter, or something like it, would seem to be hazily shadowed forth in the above extract. Th a excellent transmitter, by the way, reminds us how near Reiss was to the invention of a speaking telephone when he made his musical one with its parchment diaphragm and platinum contacts.

Local Boards and the Electric Light.—No local authority in England, says the *Local Board Chronicle*, has as yet obtained from Parliament the exclusive privilege of supplying the electric light within its district. Of the many applications which were made with this object during the last Session one and all were refused. In some few instances, however, the action taken by the authorities in the matter was not altogether barren of results. Important powers in rela tion to lighting by electricity have been obtained by the Corporations of Liverpool, Leicester, Nottingham, and Over Darwen; and similar powers will probably be given next year to such Corporations as may go to the expense of applying for them. Each of the above-mentioned Corporations has been authorised to manufacture and supply the electric light during a period of five years, from the 29th of September last, for the purposes of lighting streets and places of public resort, but for no other purpose. Each of the Local Acts by which these powers are given contains its own definition of "places of public resort." The definition in all cases includes premises used by or belonging to the Corporation, railway stations, theatres, and public slaughter houses. Places of public worship, public gardens, concert rooms, markets, and other places of public resort which the Local Government Board may approve, are, in one or other of the local Acts, treated a coming within the terms of the definition, which in Liverpool also includes any premises belonging to the Mersey Docks and Harbour Board which that Board from time to time require to be lighted by electricity. The authorities will, therefore, have every reasonable facility for making experiments with the new light under the circumstances in which its use has hitherto been found most feasible, but they will not be able to enter into competition with the vendors of gas in the supply of private houses or shops. For defraying the cost of the plant and machinery which will be required in connection with the manufacture and supply of the light, and the acquisition of the necessary licenses and patents, the Corporation of Liverpool are authorised to borrow, with the consent of the Local Government Board, £50,000; and the Corporations of Leicester, Nottingham, and Over Darwen, £20,000, £30,000, and £5,000 respectively, without such consent—the period allowed for the repayment of the money thus borrowed being in each instance ten years.

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EDISON'S GENERATOR.

The following communications, in addition to those we have already printed, have appeared in the *Scientific American*:—

EDISON'S ELECTRICAL GENERATOR.

TO THE EDITOR OF THE SCIENTIFIC AMERICAN.

I notice in your last issue a communication from a gentleman named Weston denying certain results which I had stated to the writer of the criticised article regarding the efficiency of my dynamo-electric machine. His statements are without sense or science, and plainly originate from one who does not understand the laws which he pretends to set forth. I append the report of Mr. Upton, my assistant, who has made all the measurements with the Faradic machine. T. A. EDISON.

Menlo Park, N. J., October 23, 1879.

MR. EDISON: I have read very carefully the communication of Mr. Weston, which you handed me to report upon. It is impossible that the statement quoted by him, that your machine delivers nine-tenths of the electrical energy outside, is mathematically absurd, when it has been found to be practically true.

The assertion that a machine working with nine times more external than internal resistance must be "capable of increasing its own electromotive force nine times without an increased expenditure of power" is utter nonsense. Mr. Weston has evidently confounded the obtaining of a maximum of current with the obtaining of a maximum of economical efficiency. A Faradic machine with a constant field may be considered electrically, when running at a fixed speed, as a battery with a certain E.M.F. and internal resistance. Your machine, for example, has 130 volts electromotive force, and about half an ohm internal resistance. According to the reasoning in the letter in question it would be mathematically absurd to connect a battery with a resistance nine times greater than itself, and "destructive of the doctrine of the conservation and correlation of forces," since doing this with a battery is exactly similar to what you have done with your machine in the case mentioned.

To express the results with equations, the outside work may be taken as equal to $E^2 (r + R)^{-2} R$. This will be a maximum when the equation of condition that the first differential coefficient is equal to zero, is satisfied, or—$2 E^2 (r+R)^{-3} R + E^2 (r + R)^{-2} = 0$, which is the case when $R = r$. This shows the maximum is obtained when the external resistance is made equal to the internal. An experimental proof of this was given in a recent number of *La Lumière Electrique*. For example, in your machine there should be a maximum theoretically when R equals 0·5ohm, E equalling 130 volts, or when $\frac{130 \times 130}{1 \times 1} \times 0{\cdot}5 \times \frac{44{\cdot}3}{33{,}000} = 11$ horse-power can be utilised outside of the machine, while as many are lost in the machine. Again if $R = 9r$, as in the case mentioned for illustration in the *Scientific American*, that is, R = 4·5ohms, $\frac{130 \times 130}{5 \times 5} \times 4{\cdot}5 \times \frac{44{\cdot}3}{33{,}000} = 4$ horse-power can be utilised outside of the machine. In the first case, as compared to the second, 25 times as much power is lost in order that $2\frac{3}{4}$ times as much useful effect may be obtained.

Seeing that Mr. Weston has failed to understand this statement, though expressed clearly in the article he criticises, his talk about your denying the truth of Ohm's law is highly ridiculous, as well as his boastings about exposing your so-called absurd theory. His placing a few letters and equations in his letter makes more absurd the total lack of power he has to apply them. FRANCIS R. UPTON.

EDISON'S ELECTRICAL GENERATOR.

BY CHARLES A. SEELEY, PH. D.

Electric machines convert mechanical into electrical energy. The obtaining of electricity may be considered a manufacturing process, wherein steam power is the raw material and electricity the product. The best machine, other things being equal, will give the greatest yield of finished product from a given expenditure or consumption of raw material. The ratio of yield to consumption is the expression of the efficiency of the machine.

How many foot pounds of electricity can be got out of 100 foot pounds of mechanical energy? Certainly not more than 100; certainly less. What are the sources of loss, and what become of the lost foot pounds? Friction and resistance of the air inexorably demand their share in all kinds of machines. In the electric machine a heavy armature, sometimes spread out like a fanning mill, must be revolved at the rate of 500 to 1,000 times in a minute. Also there are great leakages incidental and peculiar to the electric machine, which may be summed up in the expression local actions, which consist in currents induced outside of the normal circuit, changes in the magnetism of the magnet cores, etc. How many foot pounds do we lose or are we obliged to lose out of the 100 expended? How many foot pounds of electricity are left after deducting the losses? The facts and laws of physics, with the assistance of mathematical logic, never fail to furnish precious answers to such questions. People generally, however, are not familiar with the methods and language of exact science, and prefer results of direct, plain, actual, and practical experiments, results unmixed with any abstraction. We appeal now to the testimony of such experiments.

In 1877 a committee of the Franklin Institute, consisting of ten competent and eminent experts, with a view of determining the capabilities of electrical generators, made a series of trials with the best machines then procurable. Their elaborate report describing the details of experiments was published in the May and June numbers of the Institute *Journal* of 1878. This report has become a recognised authority, and remains, so far as I know, in all respects unimpeached; and I shall use it now with fullest confidence in the accuracy of its statements. The committee experimented with six machines; three Brush, two Wallace, one Gramme. To suit my present purpose I have reduced statements of the report to the simple symmetrical form of the table below. This table shows the losses and produce of 100 foot pounds of power delivered upon each machine; the figures may be read as representing foot pounds or per cents.

1.	2.	3.	4.	5.	6.
a. Brush	16·7	33·5	50·1	50·	31·
b. ,, ...	10·4	50·9	61·1	39·	22·
c. ,, ...	11·1	41·	52·1	47·	27·
d. Wallace	8·	53·2	58·2	38·1	14·
e. ,, ...	8·6	63·	71·6	30·3	12·
f. Gramme	7·4	21·	23·4	71·2	38·

1. Names of machines.
2. Friction and resistance of the air.
3. Local actions, including all losses, except those of 2.
4. Total losses, the sum of 2 and 3.
5. Total current of the normal circuit, or the total yield of electricity.
6. The electricity utilised in producing light. It is substantially the amount utilisable for any purpose.

I present this table as worthy of thoughtful attention; it should interest all electricians. The facts which a little study will disclose may prove somewhat appalling to those whose imaginations have been busy with bringing Niagara power to New York and with the demolition of gas companies.

The facts shown in columns 5 and 6 are worthy of special attention. The total produce of electricity is shown in 5, and in 6 the practical value of that electricity; the figures in 6 are only about one-half the corresponding figures of 5. Why is it that when we have produced the electricity half of it must slip away? Some persons will be content if they are told simply that it is a way which electricity has of behaving. But there is a satisfactory, rational explanation, which, I believe, can be made plain to persons of ordinary intelligence. It ought to be known to all those who are making or using machines. I am grieved to observe that many persons who talk and write glibly about electricity do not understand it; some even ignore or deny the fact to be explained. I will try to set forth the case plainly.

Electricity moves in a circuit, and in moving disappears; that is, it is converted into some other form of energy. The same electricity does not move round and round again; it never repasses the starting point; it does not exist to repass the starting point. As it moves it falls and dies in its tracks, and its dead body at once and on the spot is resurrected, but in a changed form. Now, a part of the circuit is always and of necessity inside of the machine or battery; it is the wire of the armature or the liquids and the metals of the battery. This part of the circuit also is inaccessible, and the electricity which is here transformed is unavailable; this electricity, in fact, is worse than useless, for the heat into which it is transformed is one of the serious practical difficulties of the machine. It is, then, only the electricity which appears in the circuit outside of the machine which is utilisable.

At this point plausibly comes in a suggestion that the internal part of the circuit be made very small and the external part very large. Why not (say) make the internal part 1 and the external 9, thus saving $\frac{9}{10}$ and losing only $\frac{1}{10}$? Unfortunately the suggestion is not practical; a fallacy is concealed in it.

The electricity is truly converted throughout the entire circuit, but not evenly in proportion to the length of the circuit. The conversion takes place precisely and exactly in accord with

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the resistance in the circuit to the flow of the electricity. The electricity may be considered as distributed over the whole circuit *pari passu* with the resistance, and thereupon is transformed into energy of another name, distributed as to the quantity precisely as was the electricity. This explanation does not disclose the weakness of the suggestion, but it will assist us in finding it.

Beasts of burden and other rational creatures redouble their efforts when their burdens are increased, and "thrice is he armed," &c. Electricity behaves very differently; there are no moral suasions or reserved forces behind it. Increase its burden, and it weakens right down; it is more stubborn than a mule; it won't budge at all, except after its narrow plan. The law of the electric current is that it exists or is produced *inversely* as the resistance to its flow in the circuit; double the resistance and the current is halved; treble the resistance and the current is one-third, &c. In any machine let the armature revolve steadily, and the current produced will depend solely upon the resistance; with the least resistance you can the maximum current, with the greatest resistance you have the minimum current. Now, also, the internal resistance of any machine is constant or unalterable. In order to get any external effect, external resistance must be added to the internal. To get the greatest yield from a machine or battery, it must be short circuited; that is, the external resistance must be suppressed; but then you find yourself in the interesting predicament that all the electricity is securely bottled up in the armature and is of no good to you. On the other hand, arrange things so that the greatest part of the resistance is external, and the electricity has shrivelled up to a quantity which is utterly useless to any allopath. There is evidently a just mean; what is it? What is the best practical ratio of the external and internal resistance? The mathematical calculations which clearly and beautifully answer this question, and which take in the principle that the sum of variables is least when they are equal, are probably beyond the experience of the average reader, and I substitute a sort of cut and try method.

Let the current of the short circuited machine be (say) 100. Now add an external resistance (R″) equal to the internal (r), thereby making a doubled total resistance (R). ($r + R' = R$). The total current has become 50, and the external or utilisable part of it is 25. Treble the R, making $r = 1$ and $R' = 2$, and the total current becomes $33\frac{1}{3}$ and the utilisable part 22·2. For another trial, make external half as great as internal $r = 1$, and $R' = \frac{1}{2}$, and total current becomes 66·6, of which 22·2 is utilisable. Now we are getting indications of the fact that the greatest external current is produced *in a given time* when the external and internal resistances are equal. I recommend the reader who is not yet satisfied to continue the cut and try plan till he shall be.

But, exclaims the bright scholar who is always on the *qui vive* for flaws, it is a question of economy, and it may be best to take a little more than the given time, and so get a greater portion than the half for our use; time is cheaper than coal; or, if we must have a certain great quantity of electricity in a short time, we may build a very big machine or use a good many little ones; why not save nine-tenths of the total current? The remarks of the bright scholar are always entertaining, sometimes they are instructive. The trouble with him is that although his vision is very clear it is not so wide; he is quick to spy out a thing, but he does not observe its environments. Why not nine-tenths? It is a hard thing to do after perusing the table of results above given; but consider or imagine that the losses of a machine by friction and local action are reduced to one-tenth, so that 100 foot pounds of steam power produce 90 foot pounds of current, of which the external part of the circuit (= to the internal) shall have 45. Now, adjust external resistance so that you shall get $\frac{9}{10}$ outside and $\frac{1}{10}$ inside, and weigh and figure up the results. Instead of getting 9 for 10 invested, you have 16·2 avails of 28 invested, or at the rate of 5·8 from 10 invested. There is a clear gain by attending to the spigot, but the steady leakage at the bung was still going on. I do not mean to say that the equalising r and R′ should be an inflexible practical rule, but simply that the advantages of varying from it are not so great as some persons suppose; also the loss from local action is not constant for varying products of electricity; the illustration ought not to mislead any one, and the precise data for determining the peculiar ratio of r to R′ for the most economical working are plainly enough indicated.

Now, on looking over the above, I feel as if I had led the reader over a wearisome roundabout road when there is a short cut across lots to the destination. My excuse is that the short cut is not a familiar thoroughfare, and the average traveller cannot feel confidence in it. Mathematics is what I have in mind. To the mathematician the expression $a^2 + b^2 = e^2$ is the clear expression of the relation of the sides of right-angled triangles and many other things, but we plain people whittle up a great many shingles or pencils in the cut and try plan before we can apprehend the thing it teaches.

But there is one little expression, simple in form yet full of meaning—in fact, a mine of the elements of ideas on electricity—which I would, if I had my way about it, compel the reader to wrestle with it till he had completely mastered it. It is the expression of the principal facts about the electric circuit; it is called Ohm's law, and it is this: $C = \frac{E}{R}$. C is the strength of the current, that is, the quantity (say ft. lb.) flowing per second. E is electromotive force, an idea corresponding to tension, pressure, or head. R is resistance to the flow. (It will assist the tyro to observe that electricity has some of the properties of ordinary fluids, and that Ohm's law is true for water and steam. Let, for example, C be galls. of water per minute, E head of water, R resistance to flow, narrowness of pipes, friction, &c. The formula, however, is not useful outside of electricity, mainly for the reason of the difficulty of specifying and keeping constant the elements which constitute R.) The formula declares that C varies directly with E, and inversely with R. In any machine E varies with velocity; when the velocity is uniform E is constant, whatever be the ratio of external and internal resistance, or whatever be the produce of the machine in usable current. If it is desired to distinguish the internal (r) from the external (R′) resistance, $r + R'$ may be substituted for R, when $C = \frac{E}{r + R'}$. In any machine r is always constant, and E is constant for constant velocity; in this last case C can vary only with R′. C represents only the total C of the normal circuit; the useful C, or that which can appear as light, heat, chemical or mechanical energy outside of the machine, $= \frac{C\ (r+R')}{R'}$ &c., &c.

But about Edison's electric generator! The articles about it on pages 242 and 272 are the texts on which I have discoursed, and although I have not named the generator, it has all the time been in mind. Those who are accustomed to read between the lines, have some of my thoughts which are not yet put on paper. But lest any one should suppose that I am unfriendly to Mr. Edison and his work, I hasten to say that I am fully in accord and sympathy with the writer of page 242, when he asserts and laments that the newspaper reports of the sayings and doings of Mr. Edison were exaggerated and inaccurate, and consequently damaging to him. No one capable of making the improvements in the telegraph and telephone, for which we are indebted to Mr. Edison, could be other than an accomplished electrician. His reputation as a scientist, indeed, is smirched by the newspaper exaggerations, and no doubt he will be more careful in future. But there is a danger nearer home, indeed among his own friends, and in his very household. The lamentable case of Deacon Richard Smith and his wicked partners should serve as a warning. It is said that the Deacon was wise and good until his wicked partners got control of him, when he behaved foolishly and uttered blank nonsense. The writer of page 242 is probably a friend of Mr. Edison, but possibly, alas! a wicked partner. Why does he say such things as these?—"Mr. Edison claims that he realises 90 per cent. of the power applied to this machine in external work." "The economy of this machine is shown by the fact that one man may turn it with sufficient rapidity to maintain the electric arc of a Jablochkoff candle," &c. Perhaps the writer is a humorist, and had in his mind Colonel Sellers, Indian trader foot pounds, &c., which he could not keep out of a serious discussion; but such jests are not good.

Mr. Edison has built a very interesting machine, and he has the opportunity of making a valuable contribution to the electrical arts by furnishing authentic accounts of its capabilities.

New York, October 30, 1879.

IMPORTS AND EXPORTS.—From the trade and navigation returns for October it appears that we imported 6,665 cwts. of gutta percha in that month, the value of which amounted to £59,071. As compared with the same month in 1878 this shows an increase in the quantity imported of 4,145 cwts., and in the value of £36,121. October 1878 shows a decrease in the quantity amounting to 467 cwts. compared with the same month in 1877, the value of which was £5,931. With regard to telegraphic wires and apparatus we find that in October, 1877 the value of the exports amounted to £91,028; in October, 1878, to £30,306; and in October, 1879, to £412,201; showing that although there was a slight decrease in 1878 as compared with 1877, an immense increase has taken place this year, amounting to £321,173 more than in 1877, and no less than £381,895 more than in 1878.

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METHOD IN INVENTION.

It is almost impossible in a short title to convey the idea which leads to our writing this article. The question raised has not hitherto been treated in these columns; in fact, it has been carefully avoided, because it cannot be fully discussed without entering on the vexed question of State or other aid to science.

There is one class of persons who hold that the majority of useful inventions are the outcome from practical men, another and quite as large a class maintains that the most useful inventions have emanated from the laboratory of the student. Each support their argument by examples, well selected, and which cannot well be controverted. The unbiassed looker on, however, generally comes to the conclusion that both parties are right and both are wrong—right as to their facts and deductions, wrong in refusing to accept the facts of their opponents. Is it not that the germs of great innovations, the new departures, are generally the work of students, while the steady unremittent modification and perfecting of apparatus is the work of the practical man? Just as we have men who devote their lives to the study and extension of pure mathematics, men who have hardly a thought in common with their brother students of applied mathematics, so also we have men devoted to pure science, and others devoted to applied science. The former by deduction or inductive reasoning and experimental research, discover new laws, and perhaps exemplify these laws by simple laboratory experiments, leaving the latter to devise apparatus whereby the discovery is made beneficial to the world at large.

Thurston, in his history of the steam engine, calls particular attention to the important truth that great inventions are never, and great discoveries are seldom, the work of any one mind. Every great invention is either an aggregation of minor inventions, or the final step of a progression. It is a growth, not a creation—hence similar inventions are brought out about the same time in widely different places. They are the fruit of past labours, the edifice that requires but the ridge to complete it. Frequently an important invention is made before the world is ready to receive it, and the unhappy inventor learns by hard experience that it is as unfortunate to be in advance as to be behind the age. Improvements continue, and will continue; for we have but few instruments which approach perfection. The steam engine was long the dream of students, the perfect engine is the dream of students still.

Electrical apparatus is as near perfection as the steam engine, but we doubt if it be any nearer. Ages hence, some antiquarian museum will contain specimens of our instruments which will be looked upon as the tools of children in knowledge. These tools are being improved, and it is a question whether the improvements are commensurate with the brain power and physical labour spent upon them. We think not, and the reason is not far to seek. One word gives it, and that word is "ignorance." Think for an instant of the records contained in the patent office, the talent, the money, the labour expended in working out an "idea." Think again how few of these patents ever repay their authors even the pecuniary expenses involved, and hence how few bear the stern test of practical experience. Take as an example the "patents" obtained in reference to the electric light. They are to be reckoned by scores, and yet few will be remembered twelve months hence. We have referred in another column to improvements in dynamo-machines, and by taking such machines as a concrete example we may express our meaning more clearly. Directly Faraday made his grand discovery, electric machines of a more or less crude form were devised, but for all practical purposes they remained inutile till the modern improvements of Wilde, Gramme, Siemens, and others. Even most of these men seem to have worked without method, or due recognition of ascertained laws. We know the laws which must be followed to obtain the greatest effect, and yet no existing machine complies with these laws. The machine alluded to above is perhaps devised on the plan we should prefer to see followed. The inventor starts with the known laws clearly defined; he criticises all known machines in order to see how far they agree with these laws; he accepts the designs before him so far as he finds this agreement, and sets to work to improve the designs where he finds the existing ones diverging from the plain course marked out. There is no reliance upon "luck;" there is no long and elaborate series of trials to "try and find something better." This, he says, is a tangible improvement, and as such it is adopted; it is not perfection, that is yet a long way off. By some such method as this, we hold that improvements are to be made in the best and cheapest manner, and with the least possible expenditure of brain power. It would be invidious to indicate any special case of an opposite type, but generally almost all such cases resolve themselves into the experimentalist without definite aim, trying everything he can imagine in the hope that something new may turn up. Our contention, then, is this:—The would-be inventor should make himself conversant with the principles with which he has to deal, he should know what has been done, he should study closely the defects in existing arrangements, and his work should resolve itself into improving these defects. The so-called practical man, that is, the man who labours physically and not mentally, introduces, and compulsorily so, a large number of improvements. These improvements, although

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individually of minor importance, in the aggregate go a long way towards perfecting all mechanism and apparatus, and, if by any means we could induce our workmen to take a greater interest in the theoretical part of the subject, the nation and the world, as Professor Ayrton pointed out in his recent inaugural address, would ultimately be the gainers. More of method, less haphazard work, less of waste.

The following observations by Mr. Todhunter are very pertinent to our present subject:—

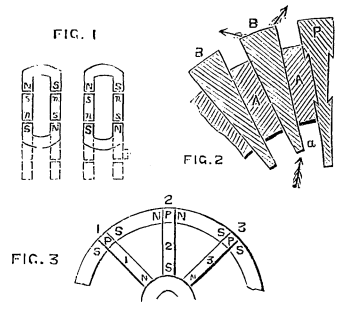
"In the present state of science there is little hope that valuable discoveries can be made by irregular excursions of persons with inadequate knowledge. If a student is pursuing his researches merely for the enjoyment which they yield to himself, he may be abundantly gratified by obtaining results which are new to him though well known to others; but if he aspires to add something of permanent value to the stores of knowledge he must begin by making himself well acquainted with the extent of those stores. It would be rash to say that nothing remains for discovery or improvement, even in the elements of mathematics, but it may be safely asserted that the ground has been so long and so thoroughly explored as to hold out little hope of profitable return for a casual adventurer."

SPRAGUE'S IMPROVEMENTS IN ELECTRIC MACHINES.

These improvements in the generation of electric currents relate to the machines called magneto-electric and dynamo-electric, in which a current is produced by the rotation or motion of a conductor in the magnetic field of either permanent magnets or electro-magnets, fed by the current produced by the machine itself. Such machines consists of two parts, one of which is called the inducing system, which consists of either the permanent or electro-magnets, of which the polar direction is always in the same direction; and the second, called the induced system, in which the direction of the current in the wires or the polar direction of the electro-magnets is subject to change. The inducing system is often called the field magnet and the induced system the armature.

Motion may be given to either of these systems or to both in opposite directions, and the whole or part of the currents set up in the induced system may pass through the inducing system, as is well understood. In the various forms of machines already constructed these two systems are arranged to act upon each other in various manners, these variations constituting the various types of construction in which sometimes one, and sometimes another of the possible reactions of the two systems upon each other is utilised. The aim of these improvements is to so arrange the two systems so as to utilise as far as possible all their reactions by placing the conductors as much as possible parallel to each other and arranging the magnets so that their several fields exert the greatest possible influence upon each other. In the earliest forms of magneto-electric machines the polar ends of the induced system are caused to pass across the ends or sides of the magnets of the inducing system or between the opposite poles of this system, as in the Alliance machine, the currents being produced only by the magnetising and demagnetising the cores of the electro-magnets. In this case it has been essential to prevent the formation of electric currents in the cores themselves, and these have been made of wires, split cylinders, and other forms in which electric conduction was avoided. In machines of this type Mr. Sprague adopts the opposite plan, and makes the core itself a conductor in which the current may circulate, and this principle he applies to other forms of electro-magnets. Such cores or electro-magnets may therefore be made of a single sheet of iron of the width necessary to constitute the electro-magnet, and wound up as compactly as may be with either any insulating material, as silk or paper, between the turns; or thin strips of insulating material may be inserted at intervals so as to form air spaces through the core. Or two or more such sheets may be arranged side by side in a similar manner so as together to form the length of the core, their several ends being connected either by means of a central rod of iron or by intermediate discs of iron otherwise insulated from the several coils, so as to form of the whole one continuous conductor in which the current shall circulate in the same direction throughout; or the core may be constructed of insulated iron wire wound similarly in a coil or helix. This iron core may either constitute the entire magnet or it may be continued as usual into a copper wire wound in the same direction as itself. The ends of such electro-magnets may be either open or terminated by iron discs or pole pieces to concentrate the magnetic action, which ends may also be utilised as electric connections, and the inventor prefers to make a radial cut in such discs to prevent the formation of a current in the disc itself.

The class of machines of the Alliance type usually contains an equal number of magnetic polar faces in the induced and inducing systems, and it consists in principle of groups such as are shown in Fig. 1, where N, S, N, S, are the inducing system which is composed usually of permanent magnets, though electro-magnets may be used; *n*, *s*, *n*, *s*, are the electro-magnets in which opposite polar faces are induced and in the wires of which currents are developed which, if the winding up of the wires is alike in all, will be in alternate directions as shown. Mr. Sprague connects each alternate conductor together either in series or in multiple arc and on well understood principles so as to form two circuits in which the currents may be collected and he may connect these two systems into one which will then have a positive and negative end; or these two circuits being alike in force he connects their similar ends together so as to form a closed circuit in which, there being equal opposed forces, no current is set up unless an external circuit, connected to the point of junction of the two circuits, is provided in which the forces can unite to produce a current. In either case he connects the ends to a collector consisting of two rings, either cylindrical on the shaft giving motion



to the induced system, or flat and concentric upon the frame carrying this system, insulating one or both of these rings, connection to which is made by springs connected to the terminals of the machine. If it is desired to convert the alternating currents thus obtained into currents in one direction these rings must be divided into interlapping sections alternately connecting each spring to one or other of the rings as is well understood. Instead of collecting all the electro-magnets of the induced system into one circuit they may be divided into groups, so as to produce two or more distinct circuits which will then require each its own collecting rings and springs. In such cases he prefers not to make the magnet poles equal in number in each system, but to leave a space between the groups of the induced system so that the groups come up to the poles of the inducing system successively in order to divide the strains. The inducing system may be made movable and the induced system fixed, in which case no collectors will be needed, but the wires of the several circuits will be connected direct to the terminals of the machine.

When the inducing system consists of permanent magnets he constructs these of sheets or bars of thin steel formed with a tongue at their ends, and connects them together in the manner shown in Fig. 2, by means of pole pieces there shown as P. These pole pieces, made of soft wrought or malleable cast iron, have grooves formed in their suitable sides to fit closely to the other parts to be joined together by them, or the wedge formed grooves may be formed in the bars, and the pole pieces have projecting keys to fit them. These pole pieces are formed in many different ways, and may have their active or true polar faces formed in projections in any manner required to direct their magnetic influence externally, and they form an important part in this invention, as they are intended to collect the magnetism of several systems of magnets, so as to unite two or more and serve as a common pole when magnetic poles of the same order are joined together by them, in which case the pole piece is a "consequent" pole, or to join several magnets or electric magnets in successive polar order when they serve simply as connections. The inventor uses them both in the inducing and the induced systems, and in the latter they enable annular systems of electro-magnets to be constructed in segments easily wound with their wires and then built up into complete rings by means of these pole pieces.

With induced systems such as belong to the Alliance type he

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employs an inducing system such as is shown in principle in Fig. 3, composed of radial magnets, the inner ends of which are united together at or by an iron cylinder or boss which forms them into a series of horse-shoe magnets. This connection may be made either by tongues and grooves, as described, or by means of brackets, or in any suitable manner. The outer ends he connects to pole pieces, shown as P^1, P^2, P^3, to which are also connected the polar ends of magnets, which will form a circle if they are curved as shown, but which if straight will form a many sided polygon. These magnets are so arranged that the several pole pieces while acting as "consequent" poles within the system collect and direct the whole of the magnetic actions externally as alternate south and north magnetic poles. It is evident that these magnets may be electro-magnets, and the same remark applies to forms described below, as the only requirement is a commutator to form the alternating currents into currents of one direction, which can be passed into the electro-magnets. He places a similar system on the other side of the induced system, with poles of opposite names opposed so as to produce the conditions shown in Fig. 1, which may be regarded as portion of all these circular systems spread out in a line. In this and similar cases the pole pieces of the two inducing systems may be further connected by horse-shoe magnets so enclosing the induced system. If several such complete systems are desired to be driven from one shaft the outer faces of the pole pieces may be fitted with straight magnets forming a connection to another inducing ring, as shown Fig. 1 in dotted lines, or to increase the power such

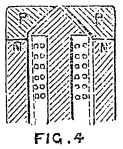

FIG. 4

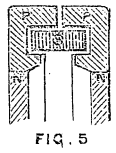

FIG. 5

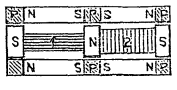

FIG. 6

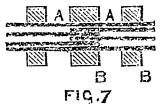

FIG. 7

magnets may be used with a single induced system, their outer ends being all united either to a ring of iron or to another ring of pole pieces and magnets. The electro-magnets of the induced system may be connected in pairs at one end, or all fixed on an iron ring or disc so as to present only one set of polar ends to the inducing system, which will then consist of only a single ring of magnets as described. Instead of forming the induced system of electro-magnets placed parallel with the axis of motion, they may be arranged radially so as to form a series of pairs like the magnets N, S, 1, 2, 3, in Fig. 3, and be constructed of sheets of iron slightly separated, so as to permit air to circulate, either forming the sheets themselves or terminating them with a pole piece of a conical section, as shown in Fig. 4, so that the pole pieces of the induced system (which will then have similar poles arranged opposite to each other) may enclose the electro-magnets as shown in the figure. The polar ends may be formed as rectangles or as half circles or otherwise, as so to obtain a similar result.

Instead of forming the induced system of distinct electro-magnets with free polar ends they may be formed into a series of

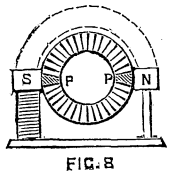

FIG. 8

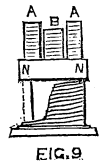

FIG. 9

segments of a circle, either as a cylinder or as the periphery of a disc or of a many sided polygon. If we remove the radial bar 2 in Fig. 3 and raise the two inner ends of bars 1 and 3 it is evident that the circle formed in this manner really represents the horse-shoe or radial magnets of the form last described so straightened out as to form the system of consequent poles intended to be produced in the modification now being described, when the several ends of the magnets come under the pole pieces of the inducing systems. Fig. 5 shows such an arrangement, in which S is a pole piece of the induced system passing between the pole pieces P, P, of the inducing system so formed as to nearly enclose the moving ring, which is thus placed nearly in the conditions of an iron rod or a helix passing through a coil carrying a galvanic current. This is shown further in Fig. 6, which represents two segments of the induced system, 1 showing the iron core and 2 the wire. In the position shown a powerful current of magnetisation and demagnetisation occurs as the induced pole pieces approach to and recede from the inducing poles. The wires are also cutting the lines of force of the pole pieces, and also of the magnetic bars of the inducing system, which are close to them, and which may if desired be attached to the whole section of the pole piece P, as shown in Fig. 5.

In machines upon this principle he does not confine himself to induced rings built up out of separate segments, as continuous rings may be employed composed of sheets of iron or discs of malleable cast iron, with the suitable pole pieces formed upon them.

In all arrangements of the two systems so far described, as many distinct external acting poles or pole pieces are required in the inducing system as in the induced, so divided that all the corresponding poles oppose each other at the same time, or else the induced system may have fewer poles so as to permit it to be divided into groups each of which successively opposes the inducing poles. The winding of the wires upon the induced system and the connections among the various sections will be arranged upon well understood principles in order to effect the same results as are already described, so as to combine the wires of the whole ring or of a group of segments into one circuit or into two circuits with opposed forces united into one, as before described; also in all of them the same kind of arrangement will be used for collecting the currents, as described.

When currents in one direction and practically continuous are desired, a construction of the induced system similar to that last described is employed and applied upon a system of Pacinotti, more commonly known as the Gramme system, that is to say, a complete magnetic circle is constructed (or in the disc form a many sided polygon) of two or more segments united together by means of pole pieces which may either project outwards to the level of the wire coils, or form an equal section with that of the other parts, forming a ring, upon the whole of which coils of wire may be placed. When the core is composed of layers of sheet or malleable cast iron, instead of forming them so as to be united by pole pieces the several segments may be formed with their ends representing their pole pieces, and so that these ends may interlap with each other so as to form air spaces, as shown in Fig. 7. When this ring is of a disc form so that the wires cannot entirely cover it, the spare spaces are filled up with pieces of iron, shown as B, B, in Figs. 2 and 7, forming corresponding

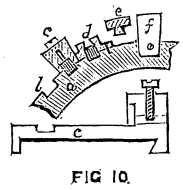

FIG 10.

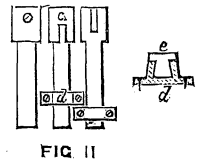

FIG 11

projections on the plates of the core, also in order to produce a series of reels or grooves in which the wire can be wound, while the projecting pieces of iron constitute subordinate or intermediary polar pieces. The projecting pieces B, B, as shown in Figs. 2 and 7 may be separate pieces of iron, and may be secured to the outer plates or there may be pins passed through the block and plates to secure them all together; slips of insulating material may be placed between the various plates under the spaces A, A, and cemented to the plates, or wooden pins may be passed through them all to hold the parts together. The object of this construction is to obtain a core in which there is little electric conduction around the core itself, and also to provide air passages through the core, so that when the ring is rotating a current of air shall be set up by the rotation, as shown by arrows in Fig. 2, similar currents of air being produced in the stationary inducing system of smaller construction by the heat itself. The wires are wound upon the core in sections, and from each section a conductor is taken to a plate of the commutator, as is already done in the systems of Gramme and others. The whole of the wire may be connected up as one circuit, or the ring may be divided into several sections according to the number of active poles in the inducing system, as is well understood, the commutator being provided with a pair of contact springs at the neutral points, either of the whole circuit or of each sectional circuit as the case may be.

The inducing system is constructed in like manner of distinct magnets or electro-magnets, with similar poles opposed and connected by pole pieces to direct their combined action towards the moving armature. This is already the arrangement in existing machines, but these magnets are, in them, straight, except in the small machines with large horse-shoe permanent magnets, and placed at a distance, and so arranged that they act only by the magnetic influence of their poles; and in many cases the arrangement of the wires is such as to reduce the effective result by their mutual actions. But here the magnets

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are in a curved form, either as flat circles or discs placed parallel with the induced system, or as a cylinder enclosing this system, or as both together; so that the induced system is acted upon not only by the poles but by traversing the whole magnetic field, and also by the current in the spires of the wire of electro-magnets when these are used. Figures 8 and 9 show the arrangement of the several systems in a machine; Fig. 8 is a side view, showing the inducing system; A is a ring constructed as described, in which the shaded parts represent the iron projections shown in larger size B, Fig. 2. At each side of the horizontal diameter there are pole pieces P, P, which take the place of one or more of the wire spaces in order to produce a massive pole. To these pole pieces are secured the heads of electro-magnets N, S, which constitute with the iron base a horse-shoe magnet supporting the inducing system. These magnets are for convenience shown upright and are so made in small machines, but they may be made semicircular with advantage and may be completed with another semicircular magnet, as shown in dotted lines. The winding of the wires is so arranged as to convert the pole pieces into powerful N. and S poles; Fig. 9 shows two discs A, A, connected together by these electro-magnets with the induced disc B between them. Motion is given to the induced system by a shaft, not shown, but to which it is attached by means of the projections *a* on the pole pieces P, Fig. 2, or in any convenient manner.

The construction of the commutator is shown, Figs. 10 and 11. *a* is part of the insulating cylinder in which grooves are cut, as shown *b*. In these grooves are inserted pieces of metal formed as shown by *c*, consisting of a block at one end drilled with a hole in which the conducting wire is to be secured, and also a vertical groove into which the end of the contact pieces *e* is inserted. A space is filed out towards the other end to receive the piece *d*, which may be soldered in its place; these pieces *d* are secured to the insulating cylinder as shown in plan Fig. 11, so as to be separated from each other, and these parts being secured in place, the interstices may be filled with ebonite, wood, &c., to make all secure. The pieces *e* are next slipped into the grooves thus formed for them, so as to form the actual wearing surfaces, and may be secured in place by the plate *f*. A similar construction of commutator may be applied to the machines already described when the currents are to be collected into a direct current.

CONTRIBUTIONS TO A PHYSICAL THEORY OF ELECTRICITY.

BY DESMOND G. FITZGERALD.

I.

Preliminary.

The object of the notes and considerations which I propose roughly to bring together under the above heading is threefold, viz.:—

1. To show that "Electricity"—in whatever sense the term may be used—cannot be regarded either as a "force," an "affection of matter," a "mode of motion," or a "form of energy;" but that it has a substantive existence as a physical entity, as recognised by Franklin in his Single-Fluid theory;

2. To show that the *Electroscopische Kraft* or "electroscopic energy" of Ohm, expressed as "tension," or "potential" by more modern writers," cannot be regarded as a *force;* that the term "electromotive force" applied to "potential difference" is a misnomer; and that in fact there exists in nature no *force* varying in accordance with the definition of this value, which in reality represents the *square root* of the force which is active in the production of electrical phenomena;

3. To put forward for the consideration of electricians certain simple relations, or elementary equations, of which the terms, as well of the mathematical significance, are, in my view, accordant with physical fact; so that these equations might advantageously be substituted for equivalent expressions which have no physical meaning.

Of the various views which have been advanced in relation to the nature of Electricity I shall refer only to that of Franklin, as originally propounded by him and as modified and extended according to the progress of electrical science, and to that which has been more or less vaguely brought forward in various forms by modern authorities and their disciples, since the period when the fact that heat and light (formerly classed with electricity as "imponderable elements") are undoubtedly modes of energy first obtained recognition. The "double-fluid" theory of Dufaye, which preceded that of Franklin, has always appeared to the writer as altogether untenable, in presence of the latter theory, by any one who accepts the aphorism of Newton that "Nature does not indulge in superfluous causes."* The fundamental objection to the theory in question is, if possible, strengthened by the conclusions of accomplished mathematicians, amongst whom may be mentioned Thomson and Tait, who, in their Handbook of Theoretical Physics, point out that the supposition of two different electric fluids cannot possibly correspond to fact.

The "single-fluid" theory of Franklin (the term "fluid" being adopted, for want of a better, to characterise a substance which is in reality *sui generis*)is admirably summed up by him in the following statement:—

"All bodies in their natural state are charged with a certain quantity of electricity, in each body this quantity being of definite amount. This quantity of electricity is maintained in equilibrium upon (? within) the body by an attraction which the particles of the body have for it, and does not, therefore, exert any attraction for other bodies. But a body may be invested with more or less electricity than satisfies its attraction. If it possesses more, it is ready to give up the surplus to any body which has less, or to share it with any body in its natural state; if it have less, it is ready to take from any body in its natural state a part of its electricity, so that each will have less than its natural amount. A body having more than its natural quantity is electrified *positively* or *plus*, and one which has less is electrified *negatively* or *minus*. One electric fluid is thus supposed to exist, and all electrical phenomena are referable either to its accumulation in bodies in quantities more than their natural share, or to its being withdrawn from them, so as to leave them *minus* their proper portion. Electrical excess then represents the vitreous, and electrical deficiency the resinous electricities of Dufaye; and hence the terms *positive* and *negative*, for *vitreous* and *resinous*."

The question has been frequently asked—why Franklin should have concluded that the "vitreous" rather than the "resinous" charge corresponds to the *plus* condition? So far as I am aware, there is no record of any grounds which may have determined this selection. The probability is that it was purely arbitrary; though several experimental facts were subsequently quoted in justification of it. Amongst these perhaps one of the most satisfactory is that observed by Prof. Daniell (Phil. Trans. 1839, p. 93), viz., that, when a piece of charcoal was attached to the positive (copper) pole of a battery of 70 of his cells, a portion of this substance was carried over, and deposited upon a platinum point constituting the negative pole, becoming beautifully moulded to its extremity; whereas, when the arrangement was reversed, particles of platinum were transferred to the charcoal, and deposited upon its surface in the form of fused globules.

The view in which the existence of "electricity" as an actual entity is denied, and according to which it is regarded as being merely an effect of "force" or "affection of matter"—as "fire" or flame, which of old was regarded as an element, is now understood to be simply an effect due to the evolution of incandescent gases—was first advanced by Mr. W. R. Grove, in a series of lectures delivered in the year 1843, and afterwards embodied in his celebrated work on the "Correlation of Physical Forces." The following quotations sufficiently illustrate the statements in which the view in question was insisted upon by this brilliant but sometimes inaccurate scientific generaliser:—

"Electricity is that affection of matter or mode of force which most distinctly and beautifully relates other modes of force, and exhibits, to a great extent in a quantitative form, its own relation with them, and their reciprocal relations with it and with each other. From the manner in which the peculiar force called electricity is seemingly transmitted through certain bodies, such as metallic wires, the term *current* is commonly used to denote its progress."†

Of the next quotations from this writer, consisting of the concise but unsupported assertion that "Electricity may be changed into work,"‡ it may be said that, if the statement were true in its most obvious sense, it would at once and for ever settle the question as to the nature of electricity, and that, if it be true in any sense outside of the construction that "electrical work may be converted into mechanical work" it sufficiently justifies the opinions of some other authorities as given below.

The view advanced by Mr. Justice Grove was never accepted by Faraday, whose *nescio* may, I think, be taken as a recognition of the fact that electricity can neither be referred to any category nor correlated with any force or mode of energy. In a discussion as to the nature of electricity which took place during the meeting of the British Association at Swansea, in 1848, Faraday said:—

"There was a time when I thought I knew something about the matter; but the longer I live, and the more carefully I study the subject, the more convinced I am of my total ignorance of the nature of electricity."

In addition to that of Faraday, I will here mention the names of three electricians who have never committed themselves—so far as I can ascertain—to the conclusions of Grove, nor definitively rejected, as untrue or unnecessary, the theory of Franklin. These are Clerk Maxwell, William Thomson, and Robert Sabine:

* Natura simplex est, et rerum causis superfluis non luxuriat.

† Correlation of Physical Forces. Third Edition. P. 81.

‡ *Phil. Mag.* XI. 26.

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no doubt there are others, but I could not give them with any certainty. The first-mentioned physicist—whose recent and untimely passing away is so great a loss to science—admirably expresses himself in relation to this subject, as follows:—

"While admitting electricity as we have now done to the rank of a physical quantity, we must not too hastily assume that it is, or is not, a substance, or that it is, or is not, a form of energy, or that it belongs to any known category of physical quantities. All that we have hitherto proved is that it cannot be created or annihilated, so that if the total quantity of electricity within a closed surface is increased or diminished, the increase or diminution must have passed in or out through the closed surface.

"This is true of matter, and is expressed by the equation known as the equation of continuity in hydrodynamics.

"It is not true of heat, for heat may be increased or diminished within a closed surface without passing in or out through the surface, by the transformation of some other form of energy into heat, or of heat into some other form of energy. It is not true even of energy in general, if we admit the immediate action of bodies at a distance. For a body outside the closed surface may make an exchange of energy with a body within the surface. But if all apparent action at a distance is the result of this action between the parts of an intervening medium, and if the nature of this action of the parts of the medium is clearly understood, then it is conceivable that in all cases of the increase or diminution of the energy within a closed surface we may be able to trace the passage of the energy in or out through that surface.

"There is, however, another reason which warrants us in asserting that electricity, as a physical quantity, synonymous with the total electrification of a body, is not, like heat, a form of energy. An electrified system has a certain amount of energy, and this energy can be calculated by multiplying the quantity of electricity in each of its parts by another physical quantity, called the potential of that part, and taking half the sum of the products. The quantities 'electricity' and 'potential,' when multiplied together, produce the quantity 'energy.' It is impossible, therefore, that electricity and energy should be quantities of the same category, for electricity is only one of the factors of energy, the other factor being 'potential.'"*

Prof. Balfour Stewart, in his Elementary Treatise on Heat, has articles on the "Conversion of Electricity in Motion into Heat" and on the opposite suppositious conversion. The following paragraph from this work (p. 334) removes all doubt as to the substantial agreement of this authority with the view of Grove:—

"There is, in fact, a chemical action that goes on between the zinc and the acid, in virtue of which electricity is produced; the zinc is in truth burned, and the electrical energy given out is simply proportional to the quantity of zinc consumed. This electricity is finally converted into heat by the resistance of the circuit."

Next, I may quote the opinion of Prof. F. Jenkin:—

"Electricity is the name given to the supposed agent producing the described condition of bodies. It seems to have been natural to regard this agent as a kind of very subtle fluid, and the nomenclature adopted in treating of electricity is based on this idea. There has been much wrangling as to the hypothesis of one and of two fluids. It is quite unnecessary to assume that the phenomena are due to one fluid, two fluids, or any fluid whatever."†

The following, which relates to another portion of my subject, may also be here quoted from the same author:—

"The *force* exerted (other things being equal) by the electrified body on another similar body in its neighbourhood is found to depend on the *quantity* of electricity. If I halve the quantity . . . the force will be halved."‡

(TO BE CONTINUED.)

* Electricity and Magnetism. Vol. I, p. 36.
† Electricity and Magnetism, p. 1.
‡ Ibid, p. 3.

TELEGRAPH CODES.

The following memorandum relating to a matter which has already been referred to in another page has been issued by the Eastern Telegraph Company (Limited):—

"66, Old Broad-street, London, E.C., Nov. 19, 1879.

"SIR: From the number of applications at this office, it seems to be generally believed that the telegraph companies are about to specially favour Dr. Ager's code.

"We had his distinct promise that he would submit to this and the other companies proof sheets of his code in order that we might revise it and eliminate words which experience had convinced us were telegraphically too much alike.

"Early in October Dr. Ager submitted to us two proofs of three sheets each, one set of which was much objected to. Since then he has not favoured us with any further proofs.

"We do not, of course, know whether Dr. Ager's code will be the best that can be constructed, but it is the duty of this company to inform its clients that we have had no opportunity as yet of giving this particular code the supervision we had promised and led many to believe we should exercise.

"Dr. Ager's code will, therefore, have, so far as this company is concerned, no possible advantage over any other similar publication.—Yours, &c.,

"GEORGE DRAPER, Secretary."

CANTOR LECTURES.*

RECENT ADVANCES IN TELEGRAPHY.

By W. H. PREECE, Electrician to the General Post Office.

LECTURE III.

(Delivered May 5, 1879.)

We have dealt with the nature of electricity, we have seen how it is produced, and how it is transferred from one place to another. We learned, in the first lecture, what that which is called an electrical signal is, and now we have to show how such electric signals are utilised for the reproduction of speech.

The art of telegraphy is, as was explained to you, simply the mode of transmitting to distant places the elements of language and the numerals. The elements of language are, of course, the simple A B C, and all that we have to do is—by the aid of this power, electricity—to produce symbols representing the letters of the alphabet at distant places. Now, clearly, if we can reproduce the letters of the alphabet themselves, we reduce telegraphy to its greatest simplicity. One of the earliest forms of telegraph introduced into this country was that by Wheatstone, which enabled us to read by the production or indication of the simple letters of the alphabet. Wheatstone's A B C apparatus was originally introduced in the year 1840, and was really upon a somewhat similar principle to that designed by Ronalds as far back as 1816. In Ronalds' telegraph, a disc, upon which the letters of the alphabet were printed, was caused to rotate, and the letters were indicated by mere pith-balls repelling each other at a given moment. In Wheatstone's apparatus, the letters of the alphabet are printed around a dial, and in front of that dial there is a small pointer which moves around the circle. We have here a specimen of the improved apparatus brought out by Wheatstone in the year 1858. It is what is known as the A B C apparatus. As far as mechanical construction and ingenuity are concerned, this instrument compares most favourably with any other kind, and to the perfection of its mechanical details, beauty of workmanship, and efficiency, we are entirely indebted to that mechanical genius, Mr. Stroh. Mr. Stroh's telegraphic apparatus will be shown to you in various forms, but here we have one of his earliest and finest specimens of workmanship.

Here we have a disc, or dial, on which the letters of the alphabet are printed, and in front of that dial moves a pointer, which is propelled by the current. The current itself is produced inside the box underneath the dial, by what is known as magneto-electricity. The production of electricity by the Gramme machine was referred to in the first lecture, and I will now only say that, whenever I turn this handle round, I produce for every revolution four distinct currents of electricity. These currents move the pointer or indicator over four letters. So that, when I press a key down, for instance O, I send just the number of currents that there are from A to O. Each current propels the pointer one letter, and when it comes to O no further currents go to the line, and so the letter O is indicated; and in this way I spell out the letters PREECE, and can read off my own name. This apparatus, as you see, is so simple in its mode of working that it can be placed in the hands of any old woman or little child, and its simplicity enables it to be used to a very large extent in the postal telegraph system. At many places, the post-office is kept by a small village grocer or haberdasher, who could not be expected to manipulate an instrument that required any amount of skill. This kind of instrument is also used to an enormous extent for private wire purposes. There are many merchants and professional men who have communication by this means between their house and offices, between various branches of their business, and between their hall and their stables. As an illustration of the ease with which this apparatus can be learned, I remember, on one occasion, that a telegraph-office was about to be opened in a small village in the Isle of Wight. An inspector was sent down to instruct the aged people who conducted the postal work, but, when he arrived, he found that the said couple had already opened the office, and had been taking messages for several days; and the old lady, with spectacles on nose, said that she had not had the least difficulty in understanding the apparatus. She learned it in half an hour, and sent the first public message within an hour after the instrument was fixed. This principle is utilised in nearly every country. In Germany, Messrs. Siemens have introduced an instrument like the one I now have here. It is based on the same principle as Wheatstone's A B C. There is a handle, which turns round and produces the magneto-electric currents. The circumference of the disc is divided into letters, and, as the handle traverses over the disc, currents are produced, and letters are sent by dropping the bar of the handle into a slot opposite each letter. In France, Breguet has produced a somewhat similar instrument, and, in fact, the principle has been adopted in most countries except America. It is very remarkable that in that country of invention no dial instrument of this kind, so far as I am aware, has been introduced, and this is one secret why the telephone has been so warmly received in that country. No simple telegraph that you could put in the hand of a child or any telegraphically-uneducated person existed, and so when the telephone was brought into existence the Americans seized upon it with avidity. But in England this A B C instrument is very useful, and at the end of March 31st, 1878, a total of 4,641 of these instruments were in use in the United Kingdom, and I have no doubt that at the present moment the figure has reached 5,000. On the tables is one of the original instruments of 1858, and here is one of the latest pattern. The two are intended to be shown together, as, although they are similar in appearance, there is a wonderful difference in their mechanical details; and there is scarcely a single movement in the old instrument that in the new one has not been improved upon by experience, and now the instrument is really everything that one could wish. Of course there are defects inherent to the apparatus, but there are other defects which are not due to the instrument. For instance, at one of the very largest commercial houses in London, that occupies a great number of houses, not 100 miles away from Westbourne-grove, where an A B C instrument exists, the instrument was reported to have failed. On an officer of the department arriving it was found that the failure was due to the currents passing through the clerk working the instrument whilst standing on a newly-washed floor. To mend matters he had put an iron plate on the floor to stand upon, and the

* From the *Journal of the Society of Arts* for October, 1879.

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result was to make confusion worse confounded. But when the clerk was made to stand upon a waste-paper basket the circuit was found to work thoroughly. Again, by constant turning of the handle, the journal upon which the pivot works is sometimes found to bind, and on one occasion on a circuit failing from such cause, an explanation was given that the "failure was due to the growth of the magnet." I need not tell you that magnets do not grow. Knowledge grows, and perhaps the knowledge of the individual who sent in such a report increased on that occasion. This A B C instrument is used where business is small, and where technical skill is not required. But there are stations where business is heavier, and where a little technical knowledge becomes necessary, and there is then adapted what is known as the single needle system. The needle system was first introduced by Cooke and Wheatstone in 1837, and consisted of five needles forming a single instrument. The five needles were made to indicate certain letters by their combined motion to the right or left. It was speedily found that the same result could be brought about by four needles, and owing to the difficulty of keeping wires always working, it was accidentally found by those who were working an instrument on the Blackwall railway, that an alphabet could be formed by using two needles only, and this led to the introduction of the double needle instrument. Again, it was soon afterwards found that one needle only was sufficient to enable an alphabet to be sent, and so the single needle instrument was adapted, and has remained in practical use in the country for many years. The letters of the alphabet are represented by beats of the needle, which has two movements, one to the right and the other to the left. A movement to the left and a movement to the right form the letter A. A movement to the right and three to the left form the letter B; right, left, right, left, C; once to the right and twice to the left, D; once to the left, E; and so on through the alphabet the letters are formed by combinations of beats to the right and left.

[The words, "Society of Arts" were now sent on a single needle instrument, first slowly and then rapidly.]

This instrument can be worked by an expert operator at the rate of 30, 35, or even 40 words a minute. Of all telegraph instruments, this is perhaps the simplest in construction. It merely consists of a couple of pedals which reverse the direction of the current, and a galvanometer (such as described to you in the first lecture), the needle of which is deflected to the right or left (according to the pedal depressed), and the limit of deflection is restricted by two small ivory pins. The instrument is learnt in a very short time by boys and girls, and where business is too great for the A B C, it is brought into use. It is almost universally employed by railway companies at their stations. The enormous advantage of this instrument is that it never requires adjustment or attention. It may be left untouched for 12 months, and, at the end of that time, will be found in good working order, and a message could be sent without any preliminary putting right. There is no other kind of instrument that will do this, and it is most remarkable that such an instrument has not found the same favour in other countries as it has in England. In the Postal Telegraph Department we have 3,495 of these instruments in use. There are, besides, many thousands in use on our railways.

These instruments are invaluable where several stations are placed on one wire, and especially on railways where sometimes as many as 20 or 25 stations are on one circuit. There is no instrument that I know of so thoroughly competent to discharge its duty on railways as this single needle.

Several improvements have been made in the single needle instrument within the past few years. The principal one is in the form of the needle. One cause of trouble in working these instruments is due to lightning. Lightning is the greatest enemy that the telegraph engineer has to contend with. It bursts and fuses his wire, it destroys his apparatus, and shatters his poles. Its effect on these needles is to demagnetise them. The needle on the face of the dial is attached to a needle inside which is a magnet, and, when powerful currents pass through the coils of the galvanometer, the needle has its magnetism whipped out of it, and it is then said to be demagnetised. To cure that evil, one of the earliest improvements in this apparatus was introduced by Mr. Alfred Varley, in the shape of permanent magnets, that caused the needle inside the coil to be magnetised by induction. The needle is merely a piece of soft iron, out of which lightning could not whip its magnetism, and, therefore, to a certain extent, the defect was cured. But, in severe thunderstorms, the magnetism was sometimes whipped out of the permanent magnet itself, so that, altogether, it was not a permanent cure.

Another improvement in this respect was made by Mr. Spagnoletti, of the Great Western Railway Telegraph Department, who induced the needle by the use of two larger and more powerful horse-shoe magnets, and by doing so rendered the instrument less liable to damage by lightning, and also, at the same time, more sensitive to currents. These various forms of needle instruments will be on the table, available for your inspection after the lecture.

There are some accidents to which this instrument is subject, besides those of lightning. For instance, at Dursley, on April 29th, 1874, an instrument failed to work because the front needle had been broken by a cat playing with it. Cockroaches have been found to stop the working of these instruments in the Brazils, by swarming inside the coils. In damp weather, too, the moisture collecting on the ivory pins causes the needle to stick to them, and they have to be moved by shaking the instrument, or prevented from sticking by the constant attention of the clerk in keeping the pins dry. In Ireland this defect was once remedied in a very curious way. The postmaster of a certain town wrote to the head office to say that "for seven months after we commenced to work the telegraph at this office we were troubled with the needle sticking to the ivory pins, and, after the telegraph clerk left, matters seemed to grow worse. I read with care every work I could get on magnetism and electricity, all to no purpose. One day when receiving a message I was perplexed in the extreme with the needle sticking, and really did not know what to do, as I could not get the message. Suddenly three words flashed across my mind. I applied the remedy, a cure was immediately effected, and from that day to this I have never suffered from the same cause, and the needles give a better click than formerly." The postmaster was told that this was very satisfactory, but was reminded that his report did not show what were the three magic words used which assisted him out of his difficulty. He then replied, "'Chalk your bobbins!' I have no recollection of ever having heard of this being done before. I chalk each pillar or pin on the inside, and think of patenting the idea, or perhaps the Postmaster-General will send me a Victoria cross for my invention!"

The next instrument to which I will call your attention is the Morse ink writer. This apparatus is used at stations where the business is heavier than those at which the single needle is fixed. Morse invented a telegraph instrument in 1832, but that known as the "Morse" did not come into existence until a much later period; in fact, not till 1844, and at that time he introduced what is now well known as the Morse alphabet. On the diagram here is the "Morse" alphabet. It is generally assumed that the Morse alphabet consists of dots and dashes, but the chief essential in the use of this alphabet is not the dot or the dash, but the space between either of these elements employed to form a letter. Different spaces separate the elements of a letter, the letters of a word, and the words themselves.

THE MORSE PRINTING ALPHABET.

A	· —	N	— ·
B	— · · ·	O	— — —
C	— · — ·	P	· — — ·
D	— · ·	Q	— — · —
E	·	R	· — ·
F	· · — ·	S	· · ·
G	— — ·	T	—
H	· · · ·	U	· · —
I	· ·	V	· · · —
J	· — — —	W	· — —
K	— · —	X	— · · —
L	· — · ·	Y	— · — —
M	— —	Z	— — · ·

NOTE.—In the original Morse alphabet the combined letters "Ch" are represented by four dashes, but this signal is not now used, and "Ch" is signalled as two separate letters.

In the formation of this alphabet a lesson was taken from the printer's fount. There it was found that the letters which occur most frequently in the English language were E, I, T, and consequently for these letters the simplest signs were used; E is represented by a single dot, I by two dots, and T by a dash. The letter A is represented by a dot and dash, B by a dash and three dots, C by a dash, dot, dash, dot, and so on, as you will see from the signs given above. You will observe that the greatest combination of these signs used to represent any one letter is four.

For the numerals the following signs are used:—

NUMERALS.

1	· — — — —	6	— · · · ·
2	· · — — —	7	— — — · ·
3	· · · — —	8	— — — — ·
4	· · · · —	9	— — — — — ·
5	· · · · ·	0	— — — — — —

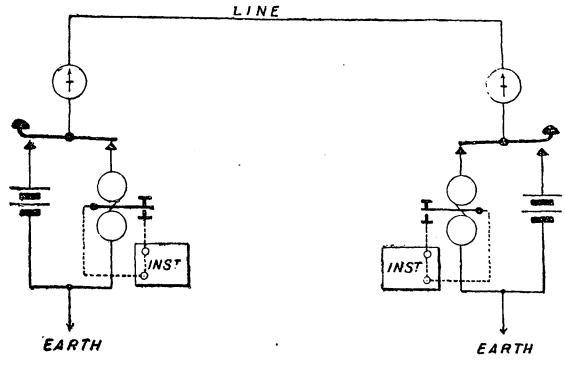
Bar of division (horizontal bar representing fractions as in ⅔), — — — — — — —.

Bar of division (oblique stroke representing shillings as in 2/3), — · · —.

NOTE.—The numerals are used on the Morse printer only. On the single needle, numbers and fractions are spelt at full length, with the signals "F I" before, and "I F" after them, to indicate that the words between must be transcribed in figures.

The space between the elements of a letter is equal to one dot, that between letters of a word is equal to three dots, and the space separating words themselves is equivalent to six dots.

You were shown in the first lecture that by passing a current through an electro-magnet attraction and repulsion are produced. This attraction and repulsion gives us mechanical power, which we turn into account, and make it the means of indicating by long or short beats the elements of letters that are sent by the current. Here is a Morse embosser. To the armature of the electro-magnet is attached a lever, at the end of which is a style. Each time the armature is attracted the bar is moved, causing the style to press upon paper ribbon, which is mechanically drawn over a ground wheel, and if a succession of short currents be sent through the electro-magnet,



SINGLE CURRENT CIRCUIT - WITH RELAY

as many dots are embossed upon the paper ribbon; or, if currents causing the armature to be held down for a sufficient time to represent the "dash" element of a letter, as many dashes appear on the paper. But this embossing is difficult to read unless you catch the shade falling upon the dots and dashes, which operation severely taxes the eyes. In 1854, Thomas John, an Austrian engineer, devised a plan by which these dots and dashes could be made in ink; and before you is one of the earliest ink-writing instruments employed, made by the eminent firm of Siemens and Halske. There is exactly the same motion as in the embosser, but instead of the style at the end of the lever, a disc is fixed, which rises and comes in contact with the paper in the reverse direction to which it is rotated. The disc dips into a small well containing ink, and as it revolves continually in the reverse direction to that of the paper, it presents ink on its circumference to the paper, and so records dots or dashes whichever may be sent. With a simple ink-writing instrument such as this it is difficult to get currents of sufficient strength to attract the armature at great distances with force enough to make a mark on the paper. In that case what are called relays are introduced. Let us suppose a line of telegraph as shown on the diagram,

(TO BE CONTINUED.)

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NEW PATENTS, 1879.

4534. Dynamo-Electric and Electro-Dynamic Machines, *C. W. Siemens.—Nov.* 6.

4549. Insulated Electric Conductors, *J. Bell.—Nov.* 9.

4555. Improvements in and Appertaining to Electro-Magnets, *J. Bell, G. Scarlett.—Nov.* 8.

4572. Conductors or Cables for Telephonic Apparatus, *W. R. Lake (communicated by E. Holmes and E. T. Greenfield.)—Nov.* 10.

4573. Electric Telegraph Apparatus, *C. D. Abel (communicated by E. George).—Nov.* 10.

4576. Improvements in Electric Lamps and the Method of Manufacturing the same, *T. A. Edison.—Nov.* 10.

4589. Improvements in Apparatus for Generating Electric Currents, also in Electric Lamps, and in the Manufacture of Carbons to be used therewith, part of which Improvements is Applicable to Electro-Magnets generally, *C. F. Heinrichs.—Nov.* 11.

4590. Apparatus and Mechanism for Electric Lighting, *G. P. Harding.—Nov.* 11.

4613. A Needle Sounder, *F. M. Roger.—Nov.* 13.

4653. Improvements in the Transmission of Power by Electricity, and in the Apparatus employed therein, *J. Hopkinson.—Nov.* 14.

ABSTRACT OF PATENTS.

835. Mariners' Compasses, *W. R. Lake.—Dated 1st March*, 1879.—*(A communication).* 6*d.*

The cover of the compass box is provided with an aperture in the centre, which is closed by a screw plug when in use. Through the aperture a key can be inserted for removing and replacing the cap as well as the pivot pin. While screwing the cap into or out of the compass-card the latter is raised off the pivot pin and kept from rotating by a lifter. The key is hollow at one end which fits over the cap or pivot, and a slot in the key receives a pin arranged outside the cap and on the shaft of the pivot pin. The upper part of the ring of the cover rises above the fluid and allows the same to expand, while the lower part of the ring extends below the level of the compass-card, and so forms an inner compartment, and prevents the access of bubbles of air from the top of the cover to the compass-card.

854. Producing and Converting Electric Force into Motive Power, *H. Port and T. Varley.—Dated 4th March*, 1879.—*(Not proceeded with).* 2*d.*

The electric force is produced by a galvanic battery, and converted into magnetism by a battery of electro-magnets. A movable armature is employed to convert the magnetism into motive force, and cams or cranks and levers collect and convey it to the machinery.

863. Electric Lamps, *C. D. Abel.—Dated 4th March*, 1879.—*(A communication).* 6*d.*

It is found that the luminous arc of electric lamps obeys the laws of Ampère in precisely the same way as an ordinary electric current, that is to say, it is attracted or repelled by electric or magnetic currents passing through metallic conductors in various directions, and it can be made to revolve round an axis under the influence of a magnet or solenoid. This property is utilised to modify and determine its position of mode of action in various ways in electric lamps. According to one arrangement the two carbons are placed parallel to each other a small distance apart, and the current before passing through them is made to pass through a wire loop running parallel with the carbons on each side and across their terminals, the current passing through the loop in the same direction as through the carbons; then, assuming that the luminous arc passes in the first instance from an intermediate point of the length of one carbon to the other, it will be influenced by the current in the loop so as to move towards that point where it will be nearest to the part of the loop in which the current flows in a direction parallel to its own direction, that is, it will move to the two terminals and be maintained there while the carbons burn away. Several other arrangements are described.

TRAFFIC RECEIPTS FOR OCTOBER, 1879.

Companies.	Oct. 1879.	Oct. 1878.	Increase.	Decrease
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	3,000 estd.	2,835	165	—
Direct Spanish Telegraph Company	1,371	1,107	264	—
Direct United States Telegraph Company	26,830 estd.	—	—	—
Eastern Telegraph Company	50,251	41,678	8,573	—
Eastern Extension Telegraph Company	31,419	23,393	8,026	—
Great Northern Telegraph Company	21,987	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—

Notice.—Chappuis' Reflectors, especially and exclusively adopted by, and fixed at, all H.M. Government offices, Buckingham Palace, Houses of Parliament, British Museum, H.M. First Commissioner of Works, South Kensington Museum, Metropolitan Board of Works, Royal Institution, Guildhall Museum, railway companies offices, hospitals, banks, manufactories, also on board H.M. ships, and generally from noblemen's mansions to artisans' workshops. 30,000 in use in London alone. Prospectus and diagrams sent on receipt of stamped envelope. Address (El.) Chappuis, Patentee and Manufacturer, 69, Fleet-street, London.—[Advt.]

TELEGRAPH SHARE LIST.

Companies.	Closing Prices Nov. 19.		Business Done Week Ending Nov. 19. Highest.		Lowest.	
Anglo-American Ordinary	55½,	¾	.....	56⅛	.....	55⅛
Do. "B"	81¼,	¾	.....	82⅜	.....	81½
Do. "A"	31,	⅛	.....	32⅝	.....	31
Brazilian	7 7-16	9-16	.....	7 9-16	.....	7⅛
Cuba	8,	½	.....	8⅜	.....	8 3-16
Do. Ten per Cent. Preference	15,	16	.....	—	.....	—
Direct Spanish	1⅞,	2⅛	.....	—	.....	—
Do. Ten per Cent. Preference	11¼,	¾	.....	—	.....	—
Direct United States	10,	¼	.....	10⅝	.....	10
Eastern	8¼,	⅜	.....	8⅜	.....	8⅜
Do. Six per Cent. Debenture	103,	6	.....	104½	.....	103⅜
Do. Five per Cent. do	103,	5	.....	104½	.....	103¾
Do. Six per Cent. Preference	11⅞,	12	.....	12⅛	.....	11⅞
Eastern Extension	8 7-16,	9-16	.....	8 9-16	.....	8 7-16
Do. Six per Cent. Deb.	103,	9	.....	—	.....	—
German Union	7⅜,	8	.....	—	.....	—
Globe Telegraph and Trust	4 15-16,	5 1-16	.....	5⅛	.....	5
Do. Six per Cent. Preference	11,	⅛	.....	11¼	.....	11
Great Northern	8⅛,	¾	.....	8¾	.....	8⅝
Indo-European	22⅛,	3⅛	.....	22⅝	.....	22⅝
Mediterranean Extension	2¾,	3¼	.....	—	.....	—
Do. Eight per Cent. Preference	9⅜,	10⅛	.....	10	.....	10
Reuter's	9⅛,	10⅛	.....	10⅛	.....	10
Submarine	227,	32	.....	230⅛	.....	230
West India and Panama	1⅜,	⅝	.....	1½	.....	1½
Do. Six per Cent. Preference	7¼,	½	.....	7 9-16	.....	7⅜
Western and Brazilian	4¼,	½	.....	4½	.....	4¼
West. Union Seven per Ct. 1st Mt.	120,	5	.....	—	.....	—
Do. Six per Cent. Sterling	105,	7	.....	106	.....	105⅛

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MR. J. C. STEVENS has received instructions from the BRITISH TELEGRAPH MANUFACTORY COMPANY (LIMITED) to SELL by AUCTION, at his Great Rooms, 38, King-street, Coveat Garden, on FRIDAY, December 5, at half-past 12 precisely, the STOCK, PLANS, MATERIALS, and INSTRUMENTS, belonging to some of their departments; they include many kinds of electric, telegraphic machines, and other scientific apparatus, and the implements and materials for making the same. Also many experimental and perfected instruments connected with the inventions of Wheatstone, Morse, Pelletier, which would be interesting and useful for colleges, museums, and lecture rooms. Gramme light and plating machines, lathes, tools, anvils, vices, wire, materials and chemicals for batteries, magnets, galvanometers, bridges, rheostats, A B C instruments, cyrtographs, calculating machines, electric clocks, magnets, bells and pulls, lightning dischargers, &c., &c. May be viewed after 2 o'clock the day prior and morning of sale, and catalogues had.

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TABLE OF THE TOTAL ADDITIONS MADE UP TO DECEMBER 31, 1874, TO POLICIES OF £1,000 EACH.

Ages at Entry.	Number of Premiums Paid. Thirty.	Twenty-five	Twenty.	Fifteen.	Ten.	Five.
30	£685 10 0	£549 0 0	£434 10 0	£290 10 0	£175 0 0	£78 10 0
45	841 0 0	678 10 0	533 0 0	353 10 0	211 0 0	93 0 0
60	——	——	787 10 0	517 0 0	310 10 0	137 10 0

G. W. BERRIDGE, *Actuary and Secretary.*

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SLIP

CABUL.—According to a *Standard* telegram, the telegraph is completed to this town, and telegrams are sent along the line.

SOCIETY OF ARTS.—A silver medal has been awarded to Mr. Conrad Cooke by the Society of Arts for his paper on "Edison's New Telephone."

THE ELECTRIC LIGHT ON SHIPBOARD.—The Pacific Steam Navigation Company has successfully tried the electric light to illumine the saloon of their new steamer, the Mendoza.

CABLE SHIPS.—The s.s. Scotia and Kangaroo will, by the time this meets the eyes of our readers, have arrived at Aden with the last portion of the Cape cable, viz., the section from Aden to Zanzibar, which will be laid forthwith.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated receipts of the West India and Panama Telegraph Company for the half month ended with Nov. 15 were £2,555, against £2,377 in the corresponding period of 1878.

EDISON'S TELEPHONE AT GREENOCK.—Experiments have been made on Messrs. Thos. Skinner and Co.'s private telegraph line between Glasgow and Greenock with the Edison telephone. Conversation was carried on without the slightest hitch.

CAVENDISH.—"The Electrical Researches of the Honourable Henry Cavendish, F.R.S.," written between 1771 and 1781, edited from the original manuscripts in the possession of the Duke of Devonshire, K.G., by the late Prof. James Clerk Maxwell, have just been issued by the Clarendon Press.

TELEGRAPH MESSENGERS' INSTITUTE. — This institute, which has hitherto been held at Canonbury Tower, is about to be extended. Up to the present time 94 telegraph boys have joined the institute, and we trust that the present endeavour to make it more useful will meet with great success.

MR. H. W. POPE.—This well-known American telegraphist has resigned his position as General Superintendent of the American District Telegraph Company, and accepted a similar one with the National Bell Telephone Company. Mr. Pope has great powers of organisation, and will undoubtedly be a real acquisition to the company.

THE TELEPHONE IN HULL.—The telephone (Bell's patent) has now been in practical use for some time on Messrs. Blundell, Spence, and Co.'s long wire connecting their Beverley-road and Bankside works (length of wire being two miles five furlongs). Messages averaging fifty per day are being transmitted and received with the greatest ease and despatch.

ELECTRICAL APPARATUS FOR AMERICA.—We are so accustomed to hear Brother Jonathan crow over his exports to benighted Britain, his potted porridge for Scotland, his canned Christmas pudding for England, and his tinned potatoes for Ireland, that we shall perhaps hardly be credited when we affirm that a well-known London firm of telegraph engineers this week shipped a large consignment of telegraph plant to Chicago.

JUVENILE LECTURES.—Mr. W. H. Preece will deliver these lectures to the Society of Arts, his subjects being "The Wonders of Sound" and "The Wonders of Light," and the evenings set down are Dec. 30 and Jan. 6. Mr. Preece has amply proved his title to be ranked as an excellent popular lecturer to adults, and we are confident that he will also acquit himself successfully in his novel part of amusing and instructing the children.

MESSRS. MOLERA AND CEBRIAN.—"Yesterday, Nov. 21," says the *Crónica de Cataluna*, "Señor Cebrian was to leave San Francisco, California, for Barcelona, where experiments are to be made on a large scale for the practical divisibility of the electric light on the system invented by Señores Molera and Cebrian. Señores Molera and Cebrian are both countrymen of ours, and their invention has been acquired by a respectable house of this city."

THE WESTERN UNION AND THE AMERICAN UNION TELEGRAPH COMPANIES.—The lawsuits between these two companies have lately been entirely given in favour of the latter, and the new company has also managed to get many of the Western Union's operators into its employ. The competition is becoming keen, but we shall not be surprised if the American Government does not soon follow the example of England, and absorb all these competing interests, taking into its own hands the entire management of the telegraphs of the States.

THE TELEGRAPHIC SYSTEM OF INDIA.—The annual statistics relating to the Indian telegraphs have recently been published by the English Government, from which we learn that in 1878 the total length of lines at work was 17,647 miles, with 25,600 miles of wire. The number of messages forwarded during the year was 1,356,000, producing a revenue of £306,000. The outlay amounted to £350,400, showing a deficit of about £36,000. This loss was compensated, however, by the gratuitous transmission of no less than 70,000 Government telegrams.

JOHN ALLAN BROUN.—We regret to have to notify the death of so well known a worker in the domain of terrestrial magnetism. J. Allan Broun was born on the 21st Sept., 1817, and when only about twenty-four years of age was made director of Makerstown Observatory. In 1851 he went to India as director of the Observatory of the Maharajah of Travancore. His researches in terrestrial magnetism gained for him the Keith Medal from the Royal Society of Edinburgh in 1862, and last year he received the Gold Medal from the Royal Society of London.

DUBOSCQ'S NEW OXY-HYDROGEN LAMP.—In this lamp the oxygen escapes by three cocks instead of one, and a great silvered reflector is substituted for the lens. The apparatus is very movable, so as rapidly to direct the illuminated circle over any part of a theatre stage, or to follow an actor about the scene. Moreover, to the apparatus is added a double stop-cock, by which the oxygen can be arrested, so as to leave the hydrogen burning feebly, and in this way shut off the light at will. The instrument is likely to rival the electric lamp for use in scientific lectures.

AUSTRIAN TELEGRAPHS.—According to the report issued by the Ministry of Trade the present system of telegraphs in Austria consists of 23,069 miles of line, containing 58,919 miles of wire. This quantity includes 15,140 miles Government line, 7,650 miles railway lines, and 277 miles of private lines. There are 2,484 stations, of which 1,088 are Government, 1,301 railway, and 95 private. In the Government offices 1,772 Morse, 52 Hughes, 5 Meyer's multiplex instruments, and one d'Arlincourt translator, are in use. The total number of messages despatched was 5,087,568, the inland messages amounting to 3,563,294, the total showing an increase of 2·7 per cent. over the preceding year.

THE ELECTRIC LIGHT AND THE PARIS OPERA HOUSE.—The damage done by the gas-jets to Baudry's magnificent

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frescoes in the *foyer* of the opera has induced the Government to authorise M. Garnier to make the experiment of lighting this part of the building by electricity, as not only by this means would the frescoes be shown off to best advantage and preserved from further deterioration, but the architectural riches of this splendid hall would be brought out into more prominent relief. With a view to testing the comparative merits of the Jablochkoff and the Werdermann lamps, a competitive trial has taken place in the presence of Messrs. Garnier, Baudry, and others. The verdict is not yet given.

Manchester.—Messrs. Siemens' system of electric lighting is now to be seen in action in the Victoria-arcade. The continuous and the alternating system are used. Five lamps, worked by the alternating system, have been fixed in the arcade by Messrs. Siemens' agent in the Lancashire and Yorkshire district (Mr. J. S. Raworth), and their working is in every respect satisfactory, the light obtained being extremely brilliant, and devoid of that constant flickering tendency which so frequently mars the effect of electric lighting. Apart from these five lamps there is a display of the "continuous" system, by means of a light which hangs suspended from the glass roof, and which has now been open to public inspection for several weeks. The six lamps altogether give an excellent light.

A New Standard of Light.—In this country the standard of light is the flame from a pure spermacceti candle, weighing 1-6th of a pound, when burning at the rate of 120 grains per hour. In France it is the Carcel burner, consuming 42 grammes of pure Colza oil per hour, and yielding a light about ten times that of the English standard. Mr. L. Schwendler has pointed out that both of these are variable and defective in other respects, and proposes instead the light produced by sending an electric current through a strip of platinum of given mass and dimensions. Mr. Schwendler also states his opinion that light by incandescence will not be able to compete with the voltaic arc, because it is scarcely any cheaper than light by combustion. We may remark, however, that it is much steadier than the arc.

Divisibility of the Electric Light.—As a contribution to the controversy respecting the divisibility of the electric light, M. Lontin has published a table of results, obtained by splitting up the current from an Alliance machine, connected up for quantity, and sending it to Lontin regulator lamps. With one lamp in circuit he obtained a light of 300 Carcel burners. With two regulators in circuit each gave 118 Carcel burners, or a total of 236. With three lamps the total was 261 burners; with four lamps it was 316; with five it was 305; with six it was 414; with seven it was 364; with eight it was 288; with nine it was 268; with ten it was 240; with eleven it was 228; with twelve it was 228. It may be remarked that the case of five lamps in circuit is a curious anomaly; and that with six lamps in circuit the maximum effect was obtained.

General Electric Society (Limited).—Registered November 12th, 1879. Capital £1,000,000, in 100,000 shares of £10 each. Objects:—To acquire and use any patents now granted or hereafter to be granted to Paul Jablochkoff and any other person for improvements in electric and other lights or for the use or application of electricity, magnetism, and other similar agencies in any form whatever, to acquire and use any process for the application of such agencies, and to acquire and use patents for improvements in or additions to any such patents or processes. *Signatories*:—J. D. Shakspear, J.P., Colonel (late R.A.), Scientific Club; Robert Sabine, C.E., 7, Great Winchester-street-buildings, E.C.; R. E. Cooper, M.I.C.E., 1, Westminster-chambers, S.W.; A. C. Macrae, M.D., 119, Westbourne-terrace, Hyde Park; J. Maw, 4, East India-avenue, E.C., ironmaster; D. Campbell, 7, Quality-court, W.C., consulting analytical chemist.

H.M.S. Northampton.—This ship, lately commissioned for the North American station, has just finished a series of trials in the channel. These trials were satisfactory. We are not going to describe a modern man-of-war, but to point out that electricity is gradually extending its sphere of usefulness. This ship, as are all similar ships, is fitted with electric bells and lights. Telephones are connected between the bridge and the Conning tower with the maintop, to ascertain the changes of range in target practice, and with the engine-room. Except in the latter position, the whole worked with great success, but the noise of the machinery in the engine-room prevented the sounds of the telephone being heard with distinctness. The vessel is provided, by Captain J. Fisher's desire, with Sir W. Thomson's patent compass and sounding apparatus. Sir W. Thomson was present during the trials, and the admirable apparatus due to his genius worked without a hitch.

Eastern and South African Telegraph Company (Limited).—This company has just notified its intention of issuing £400,000 of mortgage debentures. The total issue is £600,000, of which £200,000 is already subscribed. The share capital of the company is £400,000, in 40,000 shares of £10, and this is fully subscribed. The debenture capital is secured by a first mortgage upon the Government subsidies and other revenues of the company, and will be redeemed at par within twenty years by means of an accumulative sinking fund and fifteen yearly drawings. The debentures will bear interest at 5 per cent. per annum. Besides various subsidies, amounting to £60,000, the company expects a traffic revenue amounting to £50,000 per annum, and we have no doubt that that these calculations are well within the mark. It seems to us that this debenture stock gives one of the safest forms of investment that has been for a long time brought before the public.

Majorca and Spain.—According to a recent telegram the submarine telegraphic cables between Avica, on the north coast of Spain, and Majorca, have been successfully completed, and the tests taken are perfect. This cable was manufactured for the Spanish Government by Mr. W. T. Henley, telegraphic engineer, of North Woolwich, and sent out during last summer; but in consequence of the depth of water, 500 fathoms, being twice as great as that marked on the charts, and also owing to the cable being a very heavy one, so much slack was paid out that the cable was found to several miles too short. Mr. Henley directed that the cable should be taken up again, which was done, and it was brought back to England, overhauled and lengthened, and it has now been relaid with the expenditure of only one mile more cable than was first sent. The cable has been taken over by the authorities at Avica, who have expressed their entire satisfaction with it, and also with the manner in which the undertaking has been carried out by the manufacturer.

The Temperature of the Voltaic Arc.—It is well known that the voltaic arc comprises two kinds of rays—to wit, those emitted by the incandescent carbons, and those emitted by the arc itself which bridges the gap between the ends of the carbons. The carbons give a white light, the arc a purple-blue, and the joint effect is a bluish white light. According to recent results of M. Rosetti, the two extremities of the carbons have very different temperatures from one another. The arc has a very small power of *emitting* heat as

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compared with the flame from a Bunsen burner. This we may remark, is probably due to the smaller body of heated matter in the arc as compared to the Bunsen flame. A great number of experiments have given M. Rosetti the maximum temperature of about 3,900°C for the positive carbon pole, and about 3,150° for the negative carbon pole. For the arc itself, which joins the two carbons, he has found the temperature to be much higher, namely, 4,800°C, whatever be the thickness of the arc and the intensity of the current.

The Electric Light at the British Museum.—Many of the habitual readers at the British Museum complain of the growing unsteadiness of the electric lamps recently fitted up there. They appear to have worked better at first. Now each lamp in succession is subject to fits of flickering, accompanied by a disagreeable hissing noise. The attendants have been represented by the *World* as taking to blue spectacles; but so far as we have seen this is incorrect. Indeed, one of these officials has written to *The Times* disclaiming any injury to his eyesight therefrom. The light when good gives general satisfaction, and is even brighter on the page than daylight. Whatever may be said against the innovation, it is clearly a boon to the reading public, as is testified by the numbers who regularly avail themselves of the new privilege of reading till 7 p.m. As no other known light could safely be employed, were it not for the electric light they could not enjoy this privilege at all. Doubtless, Messrs. Siemens will study to improve their lamps as far as possible.

Distributors for the Electric Light. — There is nothing new under the sun, and the British Patent Office is a mausoleum wherein many dead inventions await a joyful resurrection. For example, several patents have been taken out recently by Mr. J. Munro, Mr. C. Stewart, and others for a distributor of the electric current, in which a rapidly-revolving contact distributes pulses of the current to a series of circuits arranged radially around it. In an old patent, No. 3,298, dated December 15th, 1866, in the name of Joseph Pierre Gillard, Paris, we find substantially the same contrivance described. The Frenchman calls it a polyphore, in which "a quick revolving motion is imparted to an arbor of iron, or other suitable metal, provided in an isolated manner with a series of pairs of metal blades, to be carried in contact with a series of metal conductors fixed in the inner periphery of a drum, in the centre of which revolves the above-mentioned arbor." This is the earliest account of such a distributor we have seen, but there may be earlier ones, if we could but find them.

Improved Telegraph Wire.—To produce wire and other forms of iron of high and uniform quality, of high electrical conductivity, and capable of withstanding a high tensional and torsional strain, Mr. J. Cooke, of Rotherham, has patented an invention which consists in reducing the quantity of carbon, silicon sulphur, and manganese existing in common metal to the relative proportions in which they exist in best iron. He first produces by ordinary means and in ordinary apparatus a metal containing—iron, 99·753; carbon, 0·450; silicon, 0·077; sulphur, 0·070; and manganese, 0·890. This metal or metallic alloy he cuts into small pieces and places in a furnace and surrounds it with charcoal and subjects it to one or more currents of atmospheric air, by which means it is melted, the action of the air and the charcoal upon the metal or metallic alloy being continued until the elements in excess are reduced to their proper proportions to ensure the iron being of the quality specified. The mass of fused iron is balled up, and forged and manipulated in the ordinary way.

The French Atlantic Cable.—The following telegrams refer to the completion of this cable:—

Philadelphia, Nov. 16: The steamer Faraday, paying out the new French cable, anchored off Nausett Harbour, Cape Cod, Massachusetts, at 10 on Saturday morning. Permission to land has been obtained from the Government under certain conditions, the chief of which are that the new company shall not amalgamate with any other, nor combine to regulate rates.

Later: The Faraday buoyed the new cable ten miles off shore. In consequence, however, of the sea becoming rough, no attempt was made to land on Saturday. If weather permits, an attempt will be made to-day.

North Eastham (Massachusetts), Nov. 16: The shore end of the new French Atlantic cable has been landed, and signals have been exchanged between the shore and the Faraday. The latter leaves to-morrow at daylight, to make the final splice, 17 miles out.

Philadelphia, Nov. 19: The new French cable has been spliced. Insulation is reported perfect.

Leclanche's Battery.—An inquiry has been addressed to us respecting the expiration of the English patent for this battery. The first patent was dated March 5, 1866 (No. 670), and bears the name of George Lionel Leclanché. It describes a battery with poles formed by a zinc and a carbon (or copper) plate. The carbon (or copper) pole is covered with an insoluble salt of copper, the carbonate; brayed sandstone is placed over it between the two poles, and the whole is moistened with water containing about 20 per cent. of hydrochlorate of ammonia. In this specification Leclanché claims the use of insoluble or slightly soluble salts of copper specially moistened with a liquid solution capable by its decomposition of rendering them soluble; and especially the use of the carbonate. This patent, although, perhaps, leading up to the well-known manganese battery does not describe it. A patent dated June 16, 1866 (No. 1,637), however, describes the use of hydrochlorate of ammonia in connection with peroxide of manganese, and, in short, details the construction of the Leclanché cell, with this difference, that sand or papier maché was added as a packing between the outer vessel and the porous chamber. This specification received provisional protection only.

Notice to Owners and Masters of Fishing Vessels.—The following notice has recently been issued by the Direct United States Cable Company to owners and masters of fishing vessels:—In order to avoid the danger of losing their tackle, and also of damaging the cables of the company, captains are requested to give them a wide berth. Should any vessel, however, lose her anchor or tackle by reason of coming in contact with the telegraph cable, and will use every endeavour to save the same from damage, the company will—subject to immediate notice being given at either of the company's stations, and full particulars furnished of the circumstances—reimburse the loss, subject to adjustment, upon being satisfied of the *bonâ fides* of the claim. The directors in adopting this course confidently believe that masters of vessels will do everything in their power to protect the cables from injury. As a means of verification, and to enable the tackle to be cleared from the cable by the company's repairing ship if considered necessary, it is important (weather permitting) that the slipped anchor should be buoyed by means of a light hawser and wooden spar. For the guidance and information of fishermen, charts showing the location of this company's cables, with the depths of water, have been placed in various offices.

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CANTOR LECTURES.*

RECENT ADVANCES IN TELEGRAPHY.

By W. H. PREECE, Electrician to the General Post Office.

LECTURE III.

(CONCLUDED FROM PAGE 11.)

You have a battery, with a key, by the simple depression of which a current is sent to line. You also have a galvanometer which shows whether the current flows or not, and at the end of your line wire you have a "relay" which receives the current, however weak, and immediately brings into force a more powerful current, which passes through the electro-magnet of the instrument, and records the signals received. There has, perhaps, been more ingenuity exercised in the construction of these relays than of any other pattern of apparatus used. Here is one of the first relays ever used. It was introduced by Wheatstone to send an alarm, and was produced by the decomposition of water. The gases accumulated by the decomposition of water drove up, by pressure, a column of mercury, which made contact, and so sent an alarm. Another form of relay was by the mercury contacts made by a fork fixed at the end of a needle, as you see here. One of the earliest forms of relay introduced into America, and that which is almost universally used over there now, is the Morse. It has certain advantages over other kinds, but, being non-polarised, is abandoned in this country, and superseded to a great extent by that known as Siemens' relay. Here is another relay known as Stroh's, which is extremely delicate, and moves with the slightest current, but the most recent one is that known as the Post Office standard relay. All these instruments will be better understood by a little careful inspection; it is quite impossible for me, in the time allotted, to explain their construction. They all perform the same function, viz., to bring into play stronger and more constant currents.

The instrument I have explained to you records dots and dashes on the paper, but you will have noticed that in making these marks a certain sound or beat occurs. Sometimes we read by this sound, and the current performs the dual function of attracting consciousness, either through the eye, by reading the dots and dashes on the paper, or through the ear, by the sounds. We have here, in order to show the the actual working of the telegraph, an instrument fixed on a wire, which communicates with the Central Telegraph Station in St. Martin's-le-Grand. It is one of the simplest kind of instrument, a sounder. To show you how these sounds can be translated into the Morse alphabet, I have brought a little instrument (kindly made for me by Mr. Theiler), which emits a fairly loud tone of given pitch. [By long or short notes, Mr. Preece made evident the facility with which sounds represented the symbols of the Morse alphabet.]

This little sound-giver is very similar to one brought out some years ago by Mr. Brittain, and was called (after him) "Brittain's Busy Bee."

But the sounder instrument, instead of emitting a musical tone, simply gives a thud, though I would ask you to notice that the sound produced by the attraction of the armature is quite distinct from that made on its recoil. This kind of instrument is used to a very large extent (almost universally) in America; it is a specimen, in fact, of the "pony" sounder used in America, which I brought over on my recent visit. We have rather altered it, and, I hope, improved upon it. We will now call up the attention of the Central Station, and you will have a practical illustration of the manner in which telegraphic business is carried on. To call up an office certain signals, which represent the code of that office, are sent. Every telegraph office throughout the kingdom has its code; Liverpool, for instance, is L V; Manchester, M R; Birmingham, B M, and so on. The code for London is T S, which letters (representing the telegraphic centre of the world) are the initials of Telegraph-street, where the central office was formerly situated.

[T S answered the call, and Mr. Preece's assistant received a portion of news which had reference to Parliament then sitting].

That is the actual process adopted for the transmission of news and ordinary messages. You will readily understand upon what trifling differences in sign or tone words depend. The insertion of a dot here, or the omission of a dash there is sufficient to cause an error. But in spite of this it is very surprising and pleasing to find that out of the 100,000,000 messages repeated every year so few errors are made.

A dot will convert the word save to rave; pound is easily transposed into found, and the words dead and bad are made up of precisely the same number of dots and dashes, as

D E A D B A D

— · · · — — · · — · · · · — — · ·

the only difference being the insertion of a space; and a very sad message was sent not very long ago announcing that a favourite daughter was "dead" instead of "bad"—the signals for DE having exactly the same element as B, as shown above. After hearing this you will not be surprised that when a party of young ladies was announced as having "arrived all right," the message was delivered as "arrived all tight;" and that also when a husband went to Brighton to secure apartments, and arranged with his wife that if he found apartments he would telegraph for her to come, but if unsuccessful would return home, he telegraphed, "home to night," but she received message "come to night," and the result was that they crossed on the road. Again, a friend of mine was in Manchester, and his only child was at home unwell, he suspected, with the measles; his wife telegraphed "Rash all gone," but he received a message "cash all gone." I could repeat these errors to any extent, many ludicrous, many sad, but all simply dependent upon a very trifling change made in this rather uncertain alphabet. Still, as I said before, when we think of the enormous number of messages transmitted every year, we can only be surprised at the care and skill which prevents a greater proportion of errors.

I want particularly to call your attention to the difference between the ink-recorder and sounder. The latter is the instrument now coming into use with tremendous strides. It has had to force its way a good deal against prejudice and ignorance, but it is steadily and surely making its way into this country. Its extreme simplicity is most striking. In the the apparatus upon which you have just heard the news received, we have everything sufficient to fully equip a telegraph station. We have a table upon which is placed your key, galvanometer and sounder, with battery underneath. The galvanometer is simply for the purpose of indicating when a current is being received should the sounder fail. The chief advantage of this instrument is its economy. The difference between the cost of a sounder and ink-recorder is very great. Again, the clerk who reads by the sounder, and writes down the message, uses each sense separately, but with the recorder he has to refer to the slip with his eye each time he has written out as much as he has noticed by the previous glance, and this constant referring means liability to error. With the sounder the clerk's ear drinks in the sound, and it is the same to him exactly as if the sender were simply speaking to him. The sounder ensures wonderful accuracy in the transmission of telegrams; and one of the most marked effects of the introduction of this instrument has been the reduction in the number of errors made, the reason being that the hand follows the ear; if the ear has learned to read accurately by sound, the hand is sure to send accurately by sound, and this is invaluable, because where we have a good sound reader there we have a good sender, and the result is accuracy. Also, as the clerk has not to glance his eye from one paper to the other, but simply to write on as fast as he can, the rapidity of the working is increased, because he simply writes down as fast as he is sent to, and, in point of fact, the rate at which messages are taken off is simply limited by the rate at which the clerk can write. It instils in the clerks who use this apparatus care and reliance. It has a kind of disciplinary agency about it, and those who are skilful sound readers invariably turn out to be self-reliant, accurate, and valuable operators. But the principal advantage attaching to this sounder is that it in reality increases the speed of working, and thereby increases the capacity of the wire for the transaction of business. Certain disadvantages are asserted as belonging to sound reading. One objection is the loss of record. That is a very conservative notion. It is supposed that by having a record of each message that you have a check in case of error. But, as I told you, errors on the sounder are not made, and, therefore, no check is needed, and those who support the old instrument, on account of its recorder, can only be classed amongst the staunchest Conservatives that we possess. Again, it is said that there is some difficulty in reading the sounder, when other noises take place in the room or shop where it is fixed; but I can only say that in the Central and other large offices where sounders are used and many noises prevail, the sounder is in great favour, and has never been objected to on the ground of its being interfered with by extraneous noises. At other times it has been said that listeners can stand outside a telegraph office and hear all that is going on. They may do so in America, but they cannot in England, for in a well-appointed office the sounder, being placed behind the public counter, ought not to be heard (though I am afraid it often is), but, even if it is, I do not think it is likely that people who could read by sound would find it worth their while to hang about to catch unknown and unexpected messages. I do not think there is much value, if any whatever, in these objections. There are about 1,380 of these sounder instruments in use in the Postal Telegraph Department. In the next lecture I will show you the application of sound to duplex and quadruplex working.

There is another kind of sonnd-reading instrument, called the "Bell." This instrument was introduced by Sir C. Bright and his brother, Mr. E. Bright, as far back as 1853. It is after the principle of one of the earliest form of instrument, whieh also recorded its alphabet by different sounds, invented in 1837 by Steinheil. The signals are received on plates varying in sound, one representing a dot and the other a dash. [Several letters of the alphabet were sent on the instrument, also the words Society of Arts].

The signals when sent on this instrument at a rapid rate, seem to form, to an unpractised ear, quite a confusion of sounds, but I have no doubt there are many persons in the room who can easily distinguish the signals sent, and convert the apparent conglomeration of sound into ordinary language.

There are 277 of these bell instruments in use in the postal telegraph service.

Another form of sound-giving instrument, called the "Neale," from its inventor, has lately been introduced. It follows the principle of the bell, the different sounds being caused by the beating of the single needle upon metal cylinders of different tone. It is made by substituting for the induced coil of the single needle instrument an "acoustic" coil of the "Neale" pattern.

[The letters of the alphabet and a few phrases were sent upon an instrument of this kind.]

It possesses all the advantages of the single needle, with the addition of those of sound reading, and is certainly calculated to simplify some of the difficulties of telegraphy. The instrument has only lately been introduced, and though likely to be largely used in the postal telegraph service, time has not yet permitted of its being generally adopted.

There are many other instruments in daily use which I have no time now to refer to.

There are instruments which record the letters of the alphabet in bold type upon paper slip. One of the most valuable, and which is very largely used on the continent, is the Hughes type-printing instrument. It is also used in England by the Submarine Telegraph Company, and *The Times* newspaper has private wires to Paris and Vienna, and all the news that you see every morning from "Our own Correspondent" in those towns is transmitted direct, and printed in clear type on paper slips by this instrument, which can on its receipt be immediately handed over to the compositors to set up. We have only a few of these instruments in the Post Office. It was used very largely at one time, but we found that it was not equal to the speed required. They are, perhaps, a little slower in the transaction of business on the continent, or have not yet arrived at that tremendous development of business that we experience, and which compels rapidity in the performance of professional business. Nearly every night during the sitting of Parliament over 500,000 words are despatched from the Central Station, and the transmission of these 500,000 words, by the time they arrive at their destination, reaches over 2,000,000 words, so that this large total which appears in the newspapers, presented at the breakfast

* From the *Journal of the Society of Arts* for October, 1879.

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tables all over the United Kingdom, is transmitted over the telegraph wires. The instruments which enable us to deal with this enormous amount of traffic I will bring before you on a subsequent occasion.

There are also instruments which absolutely transmit one's handwriting. I have here specimens of writing and sketches that have been transmitted by the D'Arlincourt writing apparatus. This apparatus is an adaptation of an invention by Mr. Bakewell as far back as 1848. By it we are able not only to reproduce writing, but sketches and characters of any sort or kind. Here is a sketch I drew myself, of something that is supposed to be a steamer, passing some rocks that are supposed to be the Needles; but it requires a vivid imagination to distinguish either the one or the other. This picture was transmitted over 400 miles of wire, and accurately reproduced, with all its imperfections on its head. Here is also a drawing of a fish that was reproduced in like manner; as also some Chinese characters, written by a member of the Chinese Embassy, who visited our central station, and saw the instrument at work. This is the only instrument I know of capable of reproducing Chinese and Japanese characters, that are really pictures in themselves, and do not convey language to the mind by the aid of the A B C, or elements of language, but by pictorial productions.

We have here also an instrument that produces writing in another way. It is the new writing telegraph of Mr. Cowper; and the principle that has guided Mr. Cowper in the construction of his instrument is the mathematical fact that the position of any point in a curve can be determined by its distance from two rectangular co-ordinates. It is upon a similar principle that the course or curve followed by a ship is known by means of latitudes and longitudes given during the passage. The letter O, for example, is represented by a circle which is made up of what we may call two equal components at right angles to each other, and if you are able to send these two components simultaneously along a wire you are able to reproduce the letter O. You will now see that on horizontal or vertical lines being drawn by the hand at the sending instrument, similar lines are reproduced by the pen at the receiving instrument. This is done by simply varying the strength of the currents flowing through the wires. Thus these currents act upon the pen at the receiving end with varying strength, and cause it to follow an exactly similar course to that traced by the sending hand. [Mr. Cowper wrote out several specimens.]

You see that, having the power to produce the two elements of letters, it is quite easy to compose or reproduce writing. The pen moves, at the distant station, as though moved by a phantom hand. The instrument will be open for your inspection while at work, after the lecture is over, for it is quite impossible, without a careful inspection, to make its principle clear to you all.

The only other instrument to which I have to make any reference is Sir Wm. Thomson's recorder. Here are specimens of the recording instruments so largely used for working submarine cables, and you will find a very neat specimen of some words that were transmitted by this means from Heart's Content to Valentia, 150 letters being sent in 100 seconds.

I need scarcely refer to telephones. You all know what telephones are, and here are one or two samples of the ordinary Bell speaking telephone.

I ought, perhaps, to say a few words about mirror working and apparatus of that kind, but it is needless for me to dwell upon them, for I am quite sure you are all anxious to see the writing telegraph.

I have just one word, however, to say about inventors and inventions. Inventors are a difficult class to deal with. An inventor is, to a certain extent, a species of monomaniac; he is a tremendous believer in his own invention, and however inapplicable it may be, you cannot possibly convince him that he is wrong.

> He that complies against his will
> Is of the same opinion still.

Nevertheless, there have been introduced a great many very valuable and ingenious inventions in this country, though the introduction of the telephone and phonograph from America caused many people to imagine that inventive genius had forsaken these shores for the New World, and had settled amongst our cousins on the other side of the Atlantic. I do not believe it.

For any invention to take root there must always be a necessity for it, and whenever a necessity arises, invention is sure to supply the want. There is no doubt that invention is wonderfully rampant, if I may so call it, in America, that is because necessities exist there to a much larger extent than with us. Moreover, invention in America is encouraged. The press takes up with wonderful alacrity anything new that is brought out, nurses it, and brings it into notoriety.

It is very different with us. It is most difficult to incline the press in England to take up a new thing; and we are also labouring under this difficulty, that all individuals, who have failed to bring their inventions into maturity in their own country, always attempt to thrust them upon us, which makes us very sceptical indeed of new things, until they are proved to be sound and good. But whenever a necessity arises which is met by an invention, whether from America, France, Germany, or elsewhere, we always seize upon it and adapt it to our requirements without any national jealousy whatever. There is now among the audience, I see, a much respected American inventor, whose invention I hope to bring before you next meeting, and he, I am sure with others, will say that practical inventions for which a necessity exists are always appreciated and adapted in this country.

Next time I shall have the pleasure of bringing before you two very great American improvements that have been adopted by this country, and I hope, by means of a wire between this room and the Central Telegraph Station, to show you in actual operation both duplex and quadruplex elegraphy.

PHYSICAL SOCIETY.

At the meeting of this Society, on November 22, Professor Guthrie exhibited his new Retention-image Photometer. This instrument is based upon the principle of the retention of images by the eye. Two circular vertical discs of thin brass are fastened about six inches apart, on a horizontal axis, which can be turned with any velocity. Out of each of these discs four sectors are cut, reaching from near the centre to near the circumference. A perfectly similar disc is placed quite close to one of these, and can be turned stiffly on the same axis. If this disc is so turned that its openings correspond with those of its neighbour, the compound disc is like the single one. If the third disc is so turned that its opaque parts correspond with the openings of its neighbours, the compound disc is continuous (*i.e.* opaque). Between the compound and single disc are placed, edge to edge at right angles to one another, two plane mirrors in vertical planes, each mirror making an angle of 45° with the axis. Two lights which have to be compared are placed at equal distances from the mirrors, outside the discs, the stronger light near the compound disc. Each light is reflected after passing through its disc upon a transparent screen. The openings of the compound disc are regulated in size until the reflections of the two lights upon the screen are equally bright, when the discs are rapidly rotated. The openings are then inversely proportional to the intensities of the lights.

Prof. ADAMS remarked that the speed of rotation should be such as to produce a uniform field of light on the screen, a result which hand turning was not very conducive to.

Professor FOSTER observed that the use of this new photometer might be less fatiguing to the eye than those photometers which presented a steady beam to the eye undiluted with intervals of darkness during which the light is cut off as in the instrument before the meeting.

Prof. REINHOLD then read a paper by Prof. Rücker, of the Yorkshire College, Leeds, "On a Suggestion as to the Constitution of Chlorine Offered by the Dynamical Theory of Gases." If a gas of density δ consists of molecules each of which possesses m degrees of freedom, and if also the inter-molecular forces are negligable, the specific heats at constant pressure ($C\,p$) and at constant volume ($C\,v$) are connected by the two well-known equations:—

$$1^\circ \qquad (C\,p - C\,v)\,\delta = \cdot 0694$$

$$2^\circ \qquad \frac{C\,p}{C\,v} = 1 + \frac{2}{m+e}$$

where e is a quantity which depends upon the potential energy of a molecule. Hence if $C\,p$ is given by experiment $C\,v$ can be calculated from the first equation, and then $m + e$ is known from the second. Regnault determined the specific heats at constant pressure of 35 gases, and from the experiments of E. Werdemann and of Wullner it appears that his values are correct within 6 per cent., and that $m + e$ can be calculated very approximately from the above equations if $C\,p$ is given. One of the chief difficulties of the thermodynamic theory of gases has been to attribute to m and e values which would at once lead to the observed ratios of $C\,p$ and $C\,v$, and satisfy any rational supposition as to the interior mechanism of a molecule. Kundt and Warting proved that for mercury $\frac{C\,p}{C\,v} = 1{\cdot}666$, which is consistent only with the supposition that the atoms of mercury are smooth rigid spheres; and Boltsman and Bosanquet have pointed out that for a smooth rigid surface of revolution $\frac{C\,p}{C\,v} = 1{\cdot}4$, a number agreeing closely with the experimental values for Au, O, N, H CO and NO. The molecules of these gases may, therefore, be constituted of two spheres rigidly united, or, as Mr. Rücker suggests, bound together by forces which prevent the separation of their surfaces while leaving them otherwise free to move. The principal object of Professor Rücker's paper was to point out an interesting fact connected with the application of this theory to chlorine. The maximum number of degrees of freedom which a molecule composed of a smooth rigid sphere could possess would be $3\,n$, but the forces in play between the spheres might reduce this number. Thus the value of $m + e$ could not exceed, but might be less than $3\,n + e$. When the molecule consists of two atoms $e = o$, but for complexer molecules we should *cæteris paribus* expect its value to increase with the number of molecules. From two tables of results calculated by him Professor Rücker, however, finds that for a number of simple and complex gases and vapours the value of $m + e$ is for each substance less than $3\,n$, or the maximum possible value of m, while for the majority of chlorine compounds examined the reverse statement holds good, that is, the value of $m + e$ is generally greater than $3\,n$. This difference may be explained by supposing that for chlorine e is abnormally large, and that the spheres are not necessarily in contact, or that n has been taken too small, that the symbol Cl_2 is incorrect, and that the chlorine atom contains a larger number of sub-atoms than has been supposed, a supposition which accords with the recent researches of Professor Victor Meyer on the vapour density of chlorine. Professor Rücker also finds that the ratio of the specific heats of bromine and one of its compounds studied ($C_2\,H_2\,Br$) agree with those of chlorine and the corresponding chlorine compound.

Dr. SHETTLE, of Reading, then read a paper on the "Influence of Heat upon Certain Forms of Induction Coils, Considered More Especially in Relation to the Inductive Power which the Blood Exercises on the Various Structures of the Body." The author found that when a copper and a zinc wire were insulated from each other by parchment paper and paraffined silk, and wound in close proximity to each other, a (induced) current was indicated on a galvanometer, whose terminals were connected to the neighbouring ends of the zinc and copper wires respectively, the other ends being left free. When the latter were connected across, the deflection was *nil*. On raising the temperature of the two wires by causing hot water to flow inside the coil into which they were wound, the deflection was largely increased. These experiments led Dr. Shettle to imagine that there is a similar action in the animal body. The heart is made up of nerves and muscular fibres winding spirally, and some of these wind round each other so as to form a spiral chord, round which the blood capillaries also wind. Dr. Shettle compares these nerve and muscle bundles to the coils of zinc and copper wire in his experiments, and infers that electric currents may be induced in them as in the wires. The flow of the warm magnetic blood would also tend to produce currents in them. Dr. Shettle further drew attention to the fact that animals live and move in a magnetic field, and that electricity must be generated in them by their movements internal and external.

Mr. EMMOTT exhibited Crossley's form of microphone, which consists of four short rods of carbon, jointed loosely into four blocks of carbon so as to form a square. It is used as a transmitter for telephones, and Mr. Crossley regularly transmits the services of a church with it to several hearers. Its speaking, singing, and whistling powers were successfully demonstrated to the meeting.

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A PROBLEM IN CONNECTION WITH ATLANTIC CABLES.

The long deferred hope of telegraphic communication between the Old World and the New was permanently solved on the 27th of July, 1866, that is a little over thirteen years ago. The success of the attempt to lay an Atlantic cable was then a theme for every newspaper writer; now such a success seems to be hardly worth a paragraph. The work has become common, and the ordinary writer is soon at the end of his knowledge. In our view, the completion of the new French Atlantic cable brings nearer the solution of some rather difficult problems. We have more than once dealt with the subject, but it is far from exhausted. Scientifically it adds another link to the chain of man's conquests, commercially it shows how much man yet lacks of forethought and prudence.

Although England is the home, as well as the birth place of free trade, Englishmen have long learned that in some isolated cases free trade is not conducive to the public welfare. The Post Office is, of course, the most important of these cases. The punctual and quick delivery of letters necessitates a central authority and a monopoly, but the work of the Government, not carried on for gain or aggrandisement, is far different to that carried out for the benefit of an individual or individuals. Inland telegraphy, again, affords another instance in which competition was tried and found wanting. The fact that public opinion acquiesced almost without a dissentient voice in the taking over of the telegraphs shows that the country had come to the conclusion that monopoly in this case, as in that of the postal service, was desirable. There are other monopolies, of a less perfect character as regards beneficial effects, tolerated because it is seen that they are necessities. We refer to such enterprises as railways, gasworks, and waterworks. Still, whilst these are, as a rule, worked for the benefit of a few individuals, they are subject to rigid Parliamentary control.

We are inclined to believe that competitive schemes relating to Atlantic and other cables ought to be similarly subject to the control, either of Parliament, or, better still, of an international tribunal. This is an aspect of cable work needing discussion. Immense sums are required for the manufacture and laying of cables, and, unless the initiators of a new scheme could unmistakably show that existing lines were unable to carry the traffic with due regard to public convenience, or charged too high a rate for its messages, thereby obtaining immoderate profits, the tribunal, whether international or otherwise, should not countenance the carrying out of the project. Had such a tribunal been in existence at the time of the conception of the new French Atlantic cable—by, let us say, an English firm—we venture to say that scheme would not have been carried out. In fact, if our view of the problem is correct, no competent tribunal would have listened to such a scheme.

Let us consider this mathematical-commercial-social problem from various standpoints. The commercial value of telegraphic communication between two places may be looked upon as a fixed quantity at any particular time. No doubt, if two widely different periods are taken into account, the value of the quantity will be changed. The alteration is a slow one, and the fixed value takes time to develop, hence a certain time elapses after a cable is laid before its commercial value is known. In other words, after a shorter or longer period, the returns derived from telegraphic intercommunication are, from year to year, practically constant. This constant gives approximately the value of telegraphic communication between the two places. If the average rate derived from the country's capital is five per cent., then every five pounds nett of the returns show a need for one hundred pounds capital. If there be any soundness in the views we have enunciated, the value of telegraphic connection with America is a fixed quantity, say x, giving a fixed return, say y, and if forty or four hundred cables are laid over and above those absolutely needed, entailing the use of $40\,x$ or $400\,x$, the return is still y, and, in the natural course of things, the value of each cable will be depreciated till the value of the whole is equivalent to x. The difference between x and the capital actually expended is an absolute loss. It is also a needless loss, for the reasoning we have here indicated is, or can be, as well known to the promoters of competitive schemes as it is to us. Unfortunately, as a rule, promoters do not sink their own capital, but the capital of simpletons who are taken in by a plausible prospectus.

We shall watch with close attention the course of events, and it will be interesting to notice whether our reasoning proves to be sound. Our contention, plainly stated, is that practically the total value of cable property between Europe and North America cannot be increased, except by the comparatively slow development of trade, and that the value of any such property cannot be increased under ordinary circumstances by laying a superabundance of cables. The outlook for those who have promoted this new scheme is not at all a happy one, for it will of necessity, in our opinion, be a commercial failure from the first.

PRACTICAL PAPERS BY PRACTICAL MEN.

ELECTRIC BELLS.

BY W. MOSELEY.

In view of the rapidly increasing demand for various useful inventions in which electricity is the active principle, it is a fre-

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quent cause for regret that there is no simple handbook that will convey sound practical instruction to the unscientific mind. The want is more especially felt in relation to that branch of electrics which involves the use of insulated wires *permanently* fixed. Indeed, an examination of practical treatises devoted to Electrics, not in the category of public telegraphy, seems to prove that a true insight into the most important practical questions—wherever it is possessed at all—is carefully preserved as a trade secret. In the interest of all users and traders in electric plant (*i.e.*, sets of instruments permanently connected with wires to batteries) there is great need for an explosion of the secret, and for an exposure of the errors which in many cases appear to be adopted systematically.

If it were not for the important advantages derived from the use of electric bells in large establishments, and similar controlling signals for important business purposes, the system might have been superseded by pneumatics, in spite of the comparative clumsiness and defects of the latter system. We admit that in the case of a badly designed and carelessly fitted plant of electric bells, there could scarcely be a greater annoyance introduced into a house, but at the same time we assert, and will explain in simple terms, that such work *may* be done, and in some cases *is* done, in such a way that failure is impossible. The reason why steamboat transit is now so general and so safe, is that such risks as tying down or sitting upon the safety-valve were put down by the strong arm of the law, and as soon as electric bells are found to be adopted in cases where life and death are involved, which they assuredly will be, then such frail methods as are now too much in vogue will likewise be stamped out. Meanwhile we hope the present attempt to elucidate the question will be useful to both dealer and consumer. In order to understand more thoroughly what *should be* let us first explain *what is* the usual practice. We will take for illustration a set of electric house bells. There may be ten or twenty rooms fitted up, but to simplify the example we will limit the diagram to three rooms and a "call bell."

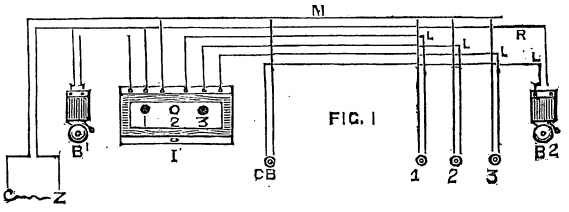

FIG. 1

C—Z is the battery, M the main wire, L L L L line wires, R return wire, B^1 B^2 the bells, I indicator, C B C, 3 C, 2 C, 1 C contactors. At present we do not wish to enter into the relative advantages of the various kinds of apparatus, but a passing remark upon the battery may prevent misunderstanding in speaking of its effects. No galvanic battery is fit to use for this purpose that requires recharging oftener than once or twice a year. That is supposing the battery is not kept in constant action by bad insulation. In such a case a battery that may be properly termed a good "constant" battery for fair use, may not last many weeks. It is, therefore, always an open question whether the battery is likely to be in good condition although it may have been new or fresh charged only three or four weeks before. Hence the necessity for a very extended trial of any new battery before it can safely be qualified as a good "constant" battery. The following have been successively in favour—shall we say in fashion—viz., Smee, Daniels (bâlloon form and other modifications), Marie Davy, Grenèt, Sulphate of Lead, Sea Salt (with large carbon negative), Leclanché. All these batteries have their good qualities, but it is the unanimous opinion of electricians of long practical experience that the Daniel, in one of its forms, and the Leclanché are as well adapted for private and public telegraphy as need be desired, but until the qualities of both can be found in one, they will both be used as circumstances dictate. The consideration of the points that must determine the question as regards which of these two should be used will be more fitly introduced further on. At present, let us suppose the battery—say the Leclanché—is joined up to the plant, as illustrated in Fig. 1. Suppose further, that the locality where it is set up is in England; then must follow another very natural supposition, viz., that dampness must intervene sometime during the year, besides the first dampness incident to any new building. The wires M L and R are insulated with a covering of gutta percha, india rubber, or some compound nostrum, and are supposed to be well protected. And so they would be under favourable circumstances. However, the work of fixing the wires, &c., was done, with a fair amount of care, science, and practical experience. The wires are neatly fixed with staples. The "electrician" probably tested the wires with a galvanometer, and found them "all right." Now, mark the result. Weeks, months, possibly years, elapse, and the work has not only given satisfaction to the owner or tenant, but has also induced others to adopt the same system. Suddenly every bell is dumb, communication from every room in the house to the kitchen, &c., is completely cut off. The "electrician" is sent for—not the journal of that name, but a man learned in the science, or one who has picked up a few "wrinkles," and is expert in the use of shibboleths. He arrives. The ridiculous inconvenience of the paralytic state of affairs fills him with proud anxiety, and he proceeds to act his part. His *rôle* may be the learned physician, Sir Oracle, or prestidigitateur. He has learned not to commit himself hastily, and at once proceeds to examine the "property." The battery is all right, bells, indicators, "pushes," "pulls," &c., all correct, but refuse to speak. He gets access to the wires, begins to test them, and is suddenly struck with agreeable perplexity. He feels he has no choice; he must play the charlatan. Then, heigh! presto! "Mary, try those bells, all of them." She does so, and the bells all seem to tinkle with delight. The household are again in telegraphic communication with Mary, and our hero, after receiving plenty of compliments and good cheer, returns home, notwithstanding, a sadder and not much wiser man, for he knows he did no good, and the same thing will happen again sooner or later. The cause of the breakdown was a rupture of the main wire somewhere between the battery C and the first branch wire. It occurred under one of the staples by the joint action of the staple injuring the insulated covering of the wire, and the galvanic current acting through the local dampness to the complete dissolution of the wire at that spot. Some slight change of temperature or vibration caused the final separation, and before the electrician could trace up to the fault, some similar movement (perhaps not the ten thousandth part of an inch) caused renewal of contact. We must not stop to discuss the reason why he did not stop to trace out and repair the fault. It might be *his* way of acting in such a case, or his employer's, or there might be exceptional difficulty in tracing out, or getting at, the fault—besides the fact that in this kind of fault no electrical test will lead up to it. Let us suppose, however, that another breakdown soon brings our hero back upon the scenes. Mark the difference in his reception. He finds his glory departed, and his efforts become so prolonged and unfortunate that a strong disposition arises to stimulate his total departure. His discovery of the fault is a slow process, and when repaired and various fixtures replaced, lo! a new dilemma confronts him. The bells again refuse to give any sign, after trying every contactor; but this time after much searching and testing on the wrong tack, he finds it is from a different cause. Instead of a rupture of the main wire, it is this time caused by metallic contact between the "main" and "return" wire, and the great danger to be feared is that the contact will get clear before it can be traced out. However, after repeated cutting and joining again it is at last traced out, and again it is found that a staple is the prime cause of the mischief. The pressure of the staple, driven too tight and the tension of the wire during extreme cold has laid bare the two wires to the extent of the merest point of space, in fact, just sufficient to allow the bare wires to touch the staple. The possibility of such an accident should call in question the soundness of the practice. But as this is the work of trained experts who like to "sail near the wind," the moral usually drawn from such a case is merely to not drive the staples too tight. And so the practice continues, some men getting more skilled, others more careless. To continue the illustration, the electrician returns home, pondering on the way, perhaps, whether the chances of such accidents are not rather too great in the case of men of less experience, but as for him *he* will not let it happen again in his work.

Not many days elapse before he is again summoned, and this time his appearance on the scene meets with a reception more befitting a convict than a steady skilled expert, for there is a growing suspicion that the mischief may be partly caused by his groping about amongst the wires, in fact, doing more harm than good. It is not that the patient is speechless this time. It is a case of madness, for the bell started ringing from no apparent cause and nothing would stop it till a duster was stuffed under it. This is now removed and away it goes again like a screeching fiend. Again a mysterious search along the wires commences, ending at last in the discovery that one of the wires L and a branch from the main wire have got in contact with the edge of the zinc tube down or up which the wires lead to the contactor. An accident of this kind would be very likely to occur if the fitter were ignorant of the consequences of carelessness on such a point, but the man who did the work "knew all about it." He was an "electrician," therefore it was the last place our present hero thought of testing, especially as his experience in previous instances pointed to other places as more likely to produce the accidental contact that caused all this trouble.

By this time the householder begins to feel that, instead of

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having paid for a "modern convenience," he finds he has paid the fee for compulsory education in the mystery of a science from which there seems to have been produced a scientific toy of the genus happy-go-lucky.

At any rate, he "wants to understand how it is there is all this trouble and uncertainty."

There is no chance of shirking the explanation, for he is close by the electrician when he discovers the fault, and, whether being "in a corner" or "off his guard," he explains the cause of the "accident," when it appears at once that no special study or training is needed to convince any sensible man that *such an accident need not* and *should not* be possible.

In the midst of his surprise and vexation a ray of light breaks in upon the victim, for he thinks "would any upright tradesman refuse to examine the fittings all through to see that no more such faults have been overlooked?" An application to this effect meets with civility, and—evasion, "for it may not occur again, &c." But *something* does occur again, *the bells all stop again.* The same electrician—however much he may dislike to meet the victimised household—must brave the ordeal, for he "knows all about the place." Once more a scientific search amongst the wires leads him, step by step, to a certain wall through which the wires pass, and, after making considerable litter with dry plaster, &c., he pulls out the faulty wire, "cut through" by the current acting through dampness. He repairs the fault, and, perhaps overvaluing certain *trade secrets*, lays the blame on the "rats" under the floors.

(TO BE CONTINUED.)

CONTRIBUTIONS TO A PHYSICAL THEORY OF ELECTRICITY.

BY DESMOND G. FITZGERALD.

(CONTINUED FROM PAGE 10.)

Professor Tyndall, whose opinion deservedly carries considerable weight, unreservedly supports the hypothesis of Grove by the following statement:—

"We have every reason to conclude that heat and electricity are both modes of motion."*

Mr. Robert M. Ferguson, in his excellent little introductory work on electricity, says:—

"It is extremely questionable whether electricity is a fluid at all. . . . If such a fluid existed, we might expect to have some traces of its separate existence, but experiment teaches us that electricity is never manifested or transmitted apart from ponderable matter. It is difficult to conceive of fluids of the nature supposed. They are in fact quite as peculiar as the phenomena which they are intended to explain. . . . Faraday has propounded a theory of electric action by induction, which, though it does not profess to overturn the other theories, in effect does so, by leaving room for the assumption that electricity need be nothing more than a molecular affection, or property of matter."

Here the first statement is one which has often been made but never adequately supported—although objections of a more or less captious nature have been made to the use of the term *fluid*. The objections put forward in the second section appear somewhat unreasonable when it is considered that the hypothetical "fluid" is one between which and every kind of ponderable matter there is an attraction which, other things being equal, augments in the ratio of the squares of the quantities of electricity separated, and that, by reason of this attraction and the almost necessary proximity of matter possessing in greater or less degree the property of conductivity, the isolation of the electric fluid would be a problem of immense difficulty. Moreover it should be pointed out that very few experiments have been made with a view to the isolation of electricity; and that, in those experiments where conductors of large surface have been electrically charged and caused to collapse, the escape of electricity, as observed in the dark, may be regarded as somewhat analogous to the escape of a fluid from a compressed sponge. And it might be argued that traces, at least, of the "separate existence" of electricity may perhaps be recognised in those "slowly-moving globes of fire" which are known as "ball lightning," if not in those flashes which, in tropical climes, appear "to drop into the ocean perpendicularly as a single stream of fire."† I imagine that those who have seen such globes and such flashes would have, generally, far less difficulty in conceiving of a fluid "of the nature supposed" than that such effects should be produced merely by the "falling back into their ordinary condition" of molecules which have been "polarised," independently of anything that can be called electricity, by "friction," or otherwise more or less gratuitously. Lastly, it may be observed that Faraday's theory of induction is not only perfectly compatible with the existence of electricity as a material entity, attracting other kinds of matter in the same way to some extent as these are influenced by affinity for each other, but is actually dependent upon the assumption of such existence, unless some other probable and sufficient cause of polarisation, discharge and accompanying electrical phenomena can be pointed out. And it is only under the latter condition, which, I contend, has never yet been supplied by any theorist, that it leaves "room for the assumption that electricity need be nothing more than a molecular affection or property of matter."

Mr. J. T. Sprague assumes, however, that Faraday's theory in effect denies the existence of an electric fluid. He says:—

"The molecular theory was founded by Faraday in his memorable experiments on induction; but it has since grown with the growth of the other sciences; it is a necessary sequence to the now established doctrine of heat being motion, and is intimately connected with the more modern and rapidly advancing doctrines of chemistry. Simply stated, it is that electricity has no existence, but that the phenomena we call electrical are due to properties and motions of the molecules of matter."*

The theory accepted by this writer, and expounded in sections 29 to 32 of his work, is tolerably satisfactory so far as it goes; but strongly reminds one of the play of "Hamlet" with the part of *Hamlet* omitted. His objections to the "fluid" explanation, which are confined to the "two-fluid" theory, are really applicable with far greater force to his own elucidation. "When two dissimilar substances," he says, "are rubbed together, a certain amount of adhesion is produced, and adhesion is of a nature closely resembling cohesion, it is simply an external attraction, as cohesion is an internal one . . . . It tends to draw the superficial molecules away from their neighbours; the opposing or complementary halves of these tend to unite, and therefore the internal attraction of the molecules themselves is weakened—they are polarised. The superficial molecules react on their neighbours; and a complete chain of excited polarised molecules is formed, along which is transferred the motion arrested by the friction, or rather the mechanical energy which but for the friction would have generated motion. It does so in any case; but if there be no resistance it effects that which we see and familiarly call motion; if there is resistance, we have the motion among the molecules, *which is electricity*." Previously to this, the author gives "one glance at the utter improbability of the 'fluid' explanation." "The fluids," he says, "have a strong attraction for themselves and for matter, yet the rubbing of two substances together is sufficient to separate the fluids from each other and the matter with which they are in quiet union." But the molecules, say in glass and silk, have also a strong attraction for each other, within these substances respectively; yet by friction, in one direction or in all directions, accompanied by some amount of *pressure*, the superficial molecules tend to be *drawn away* from their neighbours, and a chain of molecules is placed under a condition of stress, similar to that which would prevail if the normal distribution of an electric fluid had been disturbed. But why should not the molecules "fall back into their ordinary condition" when the friction is arrested? In Franklin's theory the reason is simple enough:—the separated electric "fluid" cannot recombine with its *minus* matter; and stress is a consequence of the condition which becomes substituted for the normal equilibrium. Mr. Sprague thinks that the "fluid" explanation cannot account for the fact that the electricities when "collected into separate reservoirs" do not reunite, although, at the period of charge, "these reservoirs are in actual contact." To my mind it appears that the difficulty of explanation resides only in his own hypothesis. Glancing at his diagram of a polarised chain of molecules, on p. 31 of his work, many of his readers must wonder why all the strained molecules do not revert to their normal condition; since no cause is indicated for the continuance of the state of stress. In Franklin's theory, which, when modified in accordance with Faraday's views, naturally appropriates to itself all that is valid in such elucidations as that given by Mr. Sprague, the explanation is, again, almost self-evident. The chain of polarised molecules is never complete. At one point, at least, there is a non-polarised molecule which, taken as a whole, possesses an excess of electricity, or is electrified *positively* or *plus*; and at another point there is a non-polarised molecule which has the corresponding *negative* or *minus* charge. Along the straight line and along the curved lines uniting these two molecules are other molecules "polarised," or charged *plus* and *minus* on their opposite sides, by the effect of the attraction existing between electricity and all ponderable matter, in such manner as to produce an artificial or abnormal equilibrium. And this condition is necessarily permanent, after the cause which has disturbed the normal electrical equilibrium has been removed, so long as the charged molecules are not brought, directly or indirectly, into

* "Heat as a Mode of Motion." Third edition, p. 211.

† Mr. Latimer Clark—"*Journal of the S of Tel. E.*," No. III., p. 375.

* "Electricity: its Theory, Sources and Applications," p. 21.

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conductive contact. In endeavouring to dispense with electricity as a cause of electrical effect, Mr. Sprague has given an explanation containing a large *hiatus*, which, so far as we can see, can be filled up only by one or more electrical fluids. But the fact of the existence of electricity as an actual entity is not, I think, dependent upon negative evidence or theoretical exigencies: it can be verified directly and, to a great extent, experimentally.

The following is the opinion of a distinguished electrician and electrical engineer, who does not often theorise outside of mathematics, viz., Dr. C. W. Siemens:—

"The truth revealed to us by one of the younger branches of physical science . . . . has divested heat and electricity of their mysterious character and has taught us to regard them simply as 'modes of motion.'"*

I may state that I have some reason for thinking that Mr. Latimer Clark and Mr. C. F. Varley have never held the view that electricity is in itself a mode of motion, or that there is no distinction to be made between *electricity* and *electrical energy*.

I now come to a very decided assertion made by a very able electrical engineer, Mr. W. H. Preece, and on various occasions reproduced in a more guarded form by that gentleman; though I cannot find that he has ever supported it by anything that can be admitted as an argument.

"I do not hesitate to assert it, not only as an opinion, but as a fact well substantiated by experience and by reasoning, fathered by the greatest lights of our science and taught by our leading philosophers, that electricity is no more matter than is heat, or light, or sound. Modern physicists know no such thing as the so-called electric fluid, *as a fluid*; that is, Electricity does not exist as a mass or substance occupying space, and moving from point to point in such a way as to justify the assertion so often made that 'it enters here and makes its exit there.' It is one form of energy, and therefore necessarily *force* and not *matter*."†

In the last statement, Mr. Preece—who may plead the example of Faraday and Grove—uses the term "force" in a popular and incorrect, and not in the scientific sense. The proposition that "a form of energy is necessarily *not* force" would be strictly accurate. Energy, in fact, may be equated to "force multiplied into space," and cannot in any case be expressed by one factor only of the product. It is much to be desired that writers, and speakers, on electricity would use scientific terms in their strict or mathematical sense; for the misuse of the words expressing fundamental ideas in this science has undoubtedly led to much of the confusion, misapprehension, and *apparent* diversity of opinion which prevail in electrical theory. As an instance, I need only take the word "electricity," which I have just used to designate the science, or accumulated knowledge, of electrical phenomena, facts, effects, and generalisations. The word has another legitimate meaning, prescriptive, historical and identical with that expressed by the term "electrical quantity." It signifies the presumed agency or agencies which is or are the main cause of electrical effects. It does not, in the abstract, necessarily signify the cause or causes of electrical effects, since these may possibly be independent of anything that can be characterised as electricity, as heat may be independent of "fire," although this was once recognised as the heat element. Logically, therefore, it is not incorrect to say "there is no such thing as electricity." But it is incorrect to apply the term "electricity" to an undefined course of electrical effect. Thus the expression "electricity is a force" is doubly incorrect, false in a logical as in a dynamical sense. It implies that "some force is electricity"; whereas the latter term is correctly applicable to a presumed definite agency, distinct from any force, underlying electrical phenomena. At least equally incorrect, though not betraying so great a disregard for the proper use of dynamical terms, is the statement that "electricity is a mode of energy." If we recognise the existence of "electricity" at all, then it is absolutely correct to express the verified scientific fact known as "Joule's law" by the statement that "some energy," *i.e.*, electrical energy, "is the product of quantity of electricity into electrical potential." For electricity, if there be such a thing, can, whilst constant in quantity, exist at different tensions or potentials. It follows that "electricity," in any defined or admitted signification of the term, cannot possibly be, or be generally expressed as, energy; since all modes of energy are necessarily of equivalent dimensions, and one factor of a product of two factors can express the product itself only when the other factor is unity.

(TO BE CONTINUED.)

* *Journal of the S. of Tel. E.* No. 1. p. 123.
† *Journal of the S. of Tel. E.*, No. III., p. 337.

We have received from M. C. Clamond a valuable communication, which will appear in our next issue, in relation to Edison's "Electro-Generator."

MAGNETIC CIRCUITS IN DYNAMO AND MAGNETO ELECTRIC MACHINES.*

BY LORD ELPHINSTONE AND CHARLES W. VINCENT, F.R.S.E., F.C.S., F.I.C.

The experiments which form the subject of the present note were made in connection with an investigation as to the best form for the construction of a dynamo-electric machine, intended to furnish currents of high intensity in great quantity. The principle deduced applies equally to magneto-electric machines.

The source of power in all dynamo-electric machines being electro-magnets whose cores are already slightly magnetic, it appeared to us necessary to consider the conditions under which the initial force of such machines is best obtained.

For this purpose we made use of a U electro-magnet having a core of soft iron 2 inches in diameter and 36 inches long. The arms of the U were 4 inches apart. The exciting helices were two sheet copper reels, 12 inches long, fitting closely upon the uprights of the U, but readily removable. Each of these reels was coiled with 200 yards of No. 14 double covered copper wire.

Two cores of soft iron, of the same diameter, and each 12¼ inches long, and which could be magnetised by the same helices, were also employed.

The principal armature was of soft iron, 8 inches in length, by 2 inches in width, and 1 inch thickness, rounded at the ends. Its face fitted approximately close to the poles of the U magnet, whose faces it completely covered when placed upon them.

Other armatures and magnets were employed, the form of which we propose to describe in a future paper.

The iron of which the U and the straight cores were made was found to be exceedingly plastic as regards molecular magnetic polarity. In a few seconds after the cessation of an electric current from twenty quart Bunsen cells acting through the above helices, they were incapable of attracting and holding even fine iron filings.

The U magnet tested with a suspended magnetic needle was found to retain some magnetic polarity after many days; in fact, it is doubtful if the magnetism ever entirely disappeared, except when the core was subjected to special treatment.

On the other hand, the straight cores lost their induced magnetism more rapidly, and when, having been demagnetised either by time or by the mode described further on, they were placed in the line of the magnetic dip, they showed poles in accordance therewith; and on reversing the position of the core, these poles were immediately reversed without its being necessary to resort to striking the bars or other means of putting them in a state of vibration. It was thus demonstrated to our minds that if iron of similar quality, and in this form, were made use of for the electro-magnet cores in a dynamo-electric machine, the initial force producing the electric currents of the machine could not be due to residual magnetism, but rather to the lines of magnetic force of the earth.

The current from four Bunsen cells sent round the U magnet fixed the armature so firmly that it could not be pulled, or even slid off, by the utmost exertion of one man's strength.

On breaking battery contact, if both poles were completely covered a direct pull failed to separate armature and magnet. The armature could, however, though with difficulty, be slid off; the difficulty of movement greatly increasing as the edge of the poles was approached. For instance, on attempting to slide the armature off the north, the south, or both poles, the resistance became greater as the point of final communication between the poles through the moving armature was approached. This was found to be the case whatever time had passed between the rupture of contact and the first movement of the armature. (Sometimes many days elapsed.) In very many experiments it was found, moreover, that, provided neither pole had been completely uncovered, on sliding back the armature to its normal position, the magnet, which with its stand and coils weighed over 58lb., could be lifted by it.

A current from four Bunsen cells, almost momentary in duration, sufficiently magnetised the core to produce all the above effects.

If, whilst the current flowed round the U magnet, the armature rested on one pole only, it was of course strongly held; but on breaking contact it was at once set free, and fell off if not balanced; the magnetism of the U core immediately falling to its minimum, as shown by suspended test needles. If, however, the most minute point of connection existed between the armature and the other pole, in addition to its complete contact with the one it covered, it continued to be firmly held long after battery contact was broken.

It being thought that possibly the effects described were partly due to molecular attraction of the iron atoms when brought into

* Abstract of a paper presented to the Royal Society.

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close contact under magnetic stress, the poles were coated with a layer of tallow, but if this was sufficiently thin, the magnet could still be lifted by the armature after breaking battery contact. When the tallow was broken into small lumps, allowing light to be seen between magnet and armature, the same result was obtained.

Thus absolute metallic contact was found to be unnecessary for the retention of a considerable amount of magnetism by the U core and its armature, when in magnetic circuit. With a piece of writing paper interposed between the poles and armature, they were held together with great force long after battery contact was broken; but when the distance was increased by the interposition of cards, nails, or wires, to $\frac{1}{16}$ of an inch, the residual attractive force was very much lessened. When the magnetic circuit becomes more open the residual magnetism dies away in about the same proportion as the attractive force of core and armature, whilst under the influence of the battery current, becomes less when the distance between them is increased.

Interposition of thick glazed note paper caused such a diminution of the residual magnetism that the magnet could no longer be lifted by the armature.

The experiment was varied by putting lengths of fine silk thread straight across between the armature and the magnet; in this, as in the former experiments, the armature was firmly held, and the magnet could be lifted by it. There was no point of actual metallic contact, and light could be seen over both magnetic fields, except at the thin lines where the silk threads were. The 58lb. magnet when lifted by the armature was thus literally suspended in the air (like Mahomet's coffin) by the magnetism remaining in the almost closed circuit, and this long after the exciting electric current had ceased. (The experiments were made at intervals of four hours, twenty-four hours, three days, four days; the armature had always ultimately to be wrenched off.)

The same result was obtained with plates or slips of zinc, copper, platinum, silver, and aluminium foils, gutta percha tissue, embroidery cotton, &c., and appeared to depend entirely on the distance between poles and armature, irrespective of the nature of the interposed body.

When the straight cores were placed on the poles of the U magnet, and a current passed round the latter, attraction ceased the moment the battery contact was broken; but if, while the current was passing, the armature was placed on the poles of the cores, the whole system was firmly held together, though the current no longer flowed.

There would appear to be no limit to the length of time during which the stored-up magnetic force exerts itself in such metallic circuits (closed, or nearly so) as are described above, for it was found that, after periods varying from one to fourteen days from the time of a momentary passage of an electric current round the cores, the attractive force was as great, or even greater, than at the first moment.

A small electro-magnet, U-shaped, with limbs 6 inches long, having a core of $\frac{3}{4}$-inch iron, and helices consisting of 4 layers of No. 16 covered copper wire, had for its armature a similar U core uncoiled. The uncoiled U was hung up, and the electro-magnet held beneath it, the poles of each being opposed; a current from four Bunsen cells was then sent through the coils for a few seconds. Not only did the electro-magnet (weighing, with its coils, several pounds) remain firmly attached to its armature, but the hanging on to it subsequently of 8 pounds additional weight failed to detach it.

A further proof of the large amount of magnetism held captive in a circuit thus closed was afforded by the following experiments. On connecting the ends of the wires from the helices with a galvanometer and resistance-coil, deflections varying from 40° to 90° were obtained with a resistance of 1,700 ohms in circuit each time the armature was forced away from the poles of the large U magnet, after the passage of a current from four cells of a few seconds' duration. By careful manipulation, sparks between the ends of the helix wires were also obtainable each time the closed magnetic circuit was opened. (In one case a week had elapsed betwixt the passage of the current and obtaining of the spark.)

In all these experiments, when the circuit was completely closed there was no external magnetism apparent, but on slightly breaking contact between the poles and armature, magnetic poles could be detected. Slight irregularities of the surfaces in contact likewise caused the development of poles.

A heavy magnetic needle, 4 feet distant from the magnet, if deflected by the U magnet, uncovered by its armature, 45°, would fall back to 5° when the current ceased. If the poles were now covered by the armature, the needle went to 0°. Passage of the current from four cells would now give a deflection of about 38°; on the current ceasing the needle would come back to 0°, and ise again to 5° on removal of the armature; but if, instead of immediately pulling off the armature, the two ends of the wires of the helices were connected together, and then the armature was forced off, the needle would swing 20° and fall back to 5° very slowly (in about fifteen minutes).

If both poles of the U magnet were caused to be of the same name, and the armature placed upon them, there was no attraction after breaking battery contact.

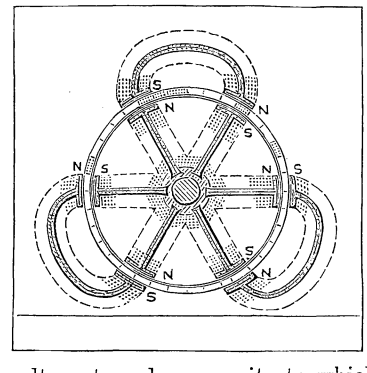
The straight cores, if placed upon the U magnet connected by the armature, and then magnetised in such a way that the poles of the cores faced like poles of the U magnet, retained no magnetic polarity when taken away from the system, whereas when they formed part of such a closed circuit as we have above described, the bars retained sufficient polarity to affect a magnetic needle for some time.

We may here remark that the attractive force of electro-magnets for each other, in what we call open circuit, is not nearly as great as in a closed circuit. For instance, the U magnet could not be lifted by the straight cores placed upon its poles, even with a current from six Bunsen cells running round the helices; but on bridging the circuit with the armature the whole mass, weighing 82lb., could be raised from the ground with the current of only two cells, and quite irrespective of the position of the exciting helices, whether both were on the magnet, both on the cores, or one on the magnet and one on the core.

From the foregoing experiments it appears clear that the more near the approach to a closed magnetic circuit, the stronger is the field of force, and the longer is retained the magnetism of the mass or masses of iron constituting the circuit. The same rule holds good with regard to permanent magnets. In closed circuits the attractive force is at its height, and diminishes in intensity as the magnetic field is more extended. But the parallel goes beyond this, for the more open the magnetic field, the more rapidly is the magnetic force itself dissipated.

These principles have guided us in the construction of a dynamo-electric machine of whose magnetic circuits we here present a sketch, and which we hope to describe more fully in a future paper.

In the accompanying diagram six fixed electro-magnets are



shown, having alternate poles, opposite to which, and at a very short distance, are placed three other electro-magnets so arranged with opposing poles as to form three nearly closed circuits. Coils of wire are made to revolve so as to cross the intervals between these opposing poles, and the electric currents induced in the moving coils are made to pass round the electro-magnets.

THE SILVERTOWN COMPANY.

The ss. Dacia, belonging to the India Rubber, Gutta Percha, and Telegraph Works Company, returned last week from the Mediterranean and Bay of Biscay after having laid a cable from Marseilles to Algiers for the French Government, and afterwards repaired a fault in the Direct Spanish Cable off Bilbao. The fault was a hole caused by a teredo close to a joint. The joint being rather large the iron wires had not quite closed themselves round it, and there were marks of the animal's attacks for several inches on one side of the actual hole. The fault, which never stopped the working of the line, was very accurately localised, and the cable was grappled so close to it that there was actually only fourteen fathoms between the fault and the point where the grapnel caught the cable. The cable laid between Bilbao and Santandar during the Carlist war was also picked up by the Dacia, and some of this was utilised for repairs. A very accurate and close line of soundings was taken across the Mediterranean, before laying the Marseilles and Algiers cable, with the Thomson wire, the break of the drum being improved so to be self-adjusting. The whole of these works were executed under the direction of Mr. Robert K. Gray, engineer to the India Rubber Company, assisted by Mr. M. E. Webb,

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electrician, and Mr. Ray, assistant engineer, and reflects great credit on Mr. Gray and his staff.

"THE POWER OF THE FUTURE," BY DR. O. J. LODGE.

The second of a series of lectures promoted by the committee of the Mechanics' Institution at Hanley, Staffordshire, was given on the above subject, on Tuesday evening, Nov. 14. The lecturer said that the wonders of electricity had become so familiarised that they did not now excite surprise, but he believed few people were at all prepared for the immense and revolutionary changes destined to be accomplished before very long by electricity, and which he expected would outstrip the achievements of steam as steam had eclipsed the water-power of their grandfathers' times. The objects of his lecture were to show the possibility and practicability of transmitting the power of flowing or falling water to any distance, without loss of force, by means of electricity, and to show the probability of utilising the large water stores which at present were allowed to run to waste because they were not in the vicinity of a seat of manufacture. He described the power of compressed air transmitted by pipes throughout the town of Schaffhausen, in Switzerland, through the utilisation of the water-falls of that place, and said that by means of electricity the transmission of power from a fall or from a river bed could be supplied not only to a small town, but to any distance, even from Schaffhausen to Berlin or Madrid. He showed the defects of the present processes of obtaining motive power, especially dwelling upon the facts that four-fifths of the energy of coal used for steam engines was wasted, pure air was consumed, and hydro-carbon generated to such an extent that if it were continued for another century there would scarcely be a patch of green country left. Besides this, the annual consumption of 200 million tons of coal per year as at present would in time exhaust all the coal mines. Referring to the Falls of Niagara, he said that this cataract was a fall of 100 million tons of water per hour down a cliff 150 feet high, the energy being equal to the power obtained by the consumption of 200 million tons of coal, allowing 3lb. of coal to each horse-power, which was about the actual rate of consumption throughout the world. This enormous motive power, which was greater than that obtained from the whole of the steam engines in use, was therefore wasted, with the exception of a ridiculously small mill which it worked. The lecturer then, with many interesting experiments and limelight views, explained and illustrated the means of producing an electric current, enumerating the various improvements effected in the application of the science, and then showed how mechanical work could be obtained from an electric current. Unfortunately, this part of the lecture was not so clearly illustrated as was intended. A small turbine representing a half horse-power had been obtained, and water brought through a hose from the mains, but the pressure was insufficient to work it satisfactorily, and the original motive power was supplied by hand instead of being obtained by water. The hand power, however, was transmitted from the platform by a current of electricity passing by a copper wire along the side of the hall to the opposite end of the room, and it was there reproduced and utilised for turning a machine. A wire was also attached to a machine in connection with a potter's lathe of the ordinary character, and on the current being applied the lathe revolved with great velocity. Dr. Lodge then showed the feasibility of conveying the power of a large central steam engine (in case of deficiency of water power) to the different rooms of a manufactory or even to the different manufactories of a town. He also read an extract from the *Staffordshire Advertiser* of October 18, relating some experiments near Paris in which water power was by the aid of a Gramme electrical machine used to work a plough. From this he argued that the application of the method under consideration to agricultural pursuits was equally practicable. He next exhibited a model of the locomotive of the future. A small locomotive engine was made, on the current being applied, to cross and recross the platform on a miniature railway. Dr. Lodge gave some information of a model railway at Berlin carried out on this plan, the machinery being worked by a current of electricity conveyed to a central rail, the energy being primarily derived from water and being collected by an electro-magnetic apparatus as the engine passes along. In concluding, he pointed out that not only would manufactures be conducted on cheaper and less wasteful principles by the "power of the future" than under the present system, but the air of towns being freed from impurities arising from the imperfect combustion of coal, manufacturing centres would, by combining the pure air of the country with efficient sanitary arrangements, be the healthy places to live in they ought to be.

ABSTRACT OF PATENTS.

872. STREET AND OTHER FIRE ALARM TELEGRAPHS, *R. S. Symington.—Dated 5th March*, 1879. 6*d*.

Each street alarm box is fitted with a push key to be pushed inwards by the person using the alarm. This push key is carried in a small barrel or tube, and is pressed outwards by a spring, and when it is pushed inwards it causes a spring arm to make a contact which closes the circuit of the wire to the district station and sounds the electric bell at that station.

876. ELECTRIC LIGHTING, *J. B. Spence.—Dated 5th March*, 1879.—*(Not proceeded with)*. 2*d*.

The points of the electrodes are formed, by preference, of platinum, and they are fitted into the ends of metallic tubes which may be in connection with pipes or vessels for supplying water or other heat-absorbing liquid to the electrodes, thereby preventing the undue heating of the points. The electrodes (one or both) are made adjustable relatively to each other, and between their points a flame is introduced obtained from the consumption of gas, oil, spirit, or other inflammable material.

PARABOLIC, CONIC, CONVEX, CONCAVE, AND EVERY DESCRIPTION OF REFLECTORS FOR ELECTRIC, LIME, OR MAGNESIUM LIGHT.—Chappuis, Manufacturer, 69, Fleet-street.—[ADVT.]

TELEGRAPH SHARE LIST.

COMPANIES.	CLOSING PRICES NOV. 26.		BUSINESS DONE WEEK ENDING NOV. 26. Highest.	Lowest.
Anglo-American Ordinary	55¾,	6¼	56⅜	54⅞
Do. "B"	81½,	2	82	80¾
Do. "A"	31,	½	31⅞	30
Brazilian	7 7-16	9-16	7 9-16	7 7-16
Cuba	8,	½	8⅜	8⅛
Do. Ten per Cent. Preference	15,	16	16	15¾
Direct Spanish	2,	⅛	2⅛	2⅛
Do. Ten per Cent. Preference	11½,	¾	11½	11½
Direct United States	10⅜,	⅜	10⅜	10
Eastern	8⅜,	½	8½	8 5-16
Do. Six per Cent. Debenture	102,	5	104	103
Do. Five per Cent. do	102,	4	103	103
Do. Six per Cent. Preference	11⅞,	12⅛	12⅛	12
Eastern Extension	8 7-16,	9-16	8⅝	8 7-16
Do. Six per Cent. Deb.	107,	9	—	—
German Union	7⅛,	8	—	—
Globe Telegraph and Trust	4 15-16,	5 1-16	5⅛	4⅞
Do. Six per Cent. Preference	11,	⅛	11⅛	11
Great Northern	8⅛,	¾	8¾	8¼
Indo-European	22½,	3½	—	—
Mediterranean Extension	2¾,	3½	2 13-16	2 13-16
Do. Eight per Cent. Preference	9¾,	10¼	—	—
Reuter's	9½,	10¼	—	—
Submarine	230,	35	230	228½
West India and Panama	1⅜,	⅝	1 9-16	1½
Do. Six per Cent. Preference	7⅜,	⅝	7⅜	7⅜
Western and Brazilian	4¼,	½	4 9-16	4⅜
West. Union Seven per Ct. 1st Mt.	120,	5	123⅞	123⅞
Do. Six per Cent. Sterling	105,	7	—	—

TRAFFIC RECEIPTS FOR OCTOBER, 1879.

COMPANIES.	Oct. 1879.	Oct. 1878.	Incrse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	3,000 estd.	2,835	165	—
Direct Spanish Telegraph Company	1,371	1,107	264	—
Direct United States Telegraph Company	26,830 estd.	—	—	—
Eastern Telegraph Company	50,251	41,678	8,573	—
Eastern Extension Telegraph Company	31,419	23,393	8,026	—
Great Northern Telegraph Company	21,987	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—

EQUITY and LAW LIFE ASSURANCE SOCIETY,
18, LINCOLN'S INN FIELDS, LONDON, W.C.
CAPITAL, £1,000,000, FULLY SUBSCRIBED.

The most stringent tables have been used in valuing the Society's liabilities. Lapsed Policies are revived within the period of three months upon payment of the overdue premium and a small fine, without evidence of health. Whole-World Licences will be granted in most cases without payment of extra premium. Nine-tenths of the profits are divided among the assured every five years. At an extraordinary general meeting held on June 9, 1875, the sum of £844,379 was set aside as the value of the Society's liabilities under its Assurance and Annuity Contracts, and £173,180 was ordered to be divided as bonus; leaving a balance of undivided profit of £20,033. Nine-tenths of the sum divided was allotted among holders of policies for £2,500,000.

TABLE OF THE TOTAL ADDITIONS MADE UP TO DECEMBER 31, 1874, TO POLICIES OF £1,000 EACH.

Ages at Entry.	NUMBER OF PREMIUMS PAID. Thirty.	Twenty-five	Twenty.	Fifteen.	Ten.	Five.
30	£685 10 0	£549 0 0	£434 10 0	£290 10 0	£175 0 0	£78 10 0
45	841 0 0	678 10 0	533 0 0	353 10 0	211 0 0	93 0 0
60	——	——	787 10 0	517 0 0	310 10 0	137 10 0

G. W. BERRIDGE, *Actuary and Secretary.*

BRITON LIFE ASSOCIATION (Limited).
Capital paid-up, Fifty Thousand Pounds.
This society has deposited £20,000 with Government, pursuant to the Life Assurance Companies' Acts.
Chief Office: 429, STRAND. City Branch: 21, CORNHILL, LONDON.

The special features and system of business of this Association comprise absolute security, moderate rates of premium, policies payable during lifetime, indisputable whole-world assurances, non-forfeitable assurances, a special section for total abstainers, and a novel and more equitable system for the assurance of invalid lives.

Prospectuses, proposal forms, and every information may be obtained on application at the chief office, 429, Strand.

JOHN MESSENT, F.I.A., Actuary and Secretary.

IMPERIAL FIRE INSURANCE COMPANY. Established 1803. 1, Old Broad-street, E.C.; and 16 and 17, Pall-mall, S.W.
Capital £1,600,000. Paid-up and invested, £700,000.

Insurances against Fire on Property in all parts of the world at moderate rates of premium.

Prompt and liberal settlement of claims.

E. COZENS SMITH, General Manager.

GRAMME MACHINES.

THE BRITISH ELECTRIC LIGHT COMPANY (Lim.),
Sole Licensees for this celebrated ELECTRIC LIGHTING MACHINE, 41, PARLIAMENT STREET, Westminster. The Directors are prepared to receive applications for Agency.

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ADDRESSES.

*** NOTICE.—It has been decided to devote a portion of the advertising space of *The Electrician* to giving the addresses and specialities of the principal firms of Electricians, Engineers, &c. A moderate charge per annum will be made for the insertion of such addresses weekly, and firms desirous to be included in the list are requested to apply to the Manager, 396, Strand. The addresses must not occupy more than five lines.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

PETER BROTHERHOOD, Engineer, 56 and 53, COMPTON-STREET, GOSWELL-ROAD, E.C.
Specialities—Patent 3-Cylinder Engines (Silver Medal, Paris), as used by Siemens, Gramme, and Wilde for driving Electric Machines.

RANSOMES, SIMS, and HEAD, Orwell Works, IPSWICH.
Specialities—Portable and Stationary Engines, fitted with patent governors, as tried in the electric lighting experiments on the Thames Embankment.

ABBOTT and Co., NEWARK-ON-TRENT.
Specialities—The "Standard Size" Vertical Cross Tube Boilers. Illustrated catalogue, giving every detail of a variety of Boilers, 2s. 6d., post free.

L. CLARK, MUIRHEAD, and Co., Electric Telegraph Engineers and Manufacturers, 29, REGENCY-STREET, WESTMINSTER.

INDIA RUBBER, GUTTA PERCHA, and TELEGRAPH WORKS, COMPANY (Limited). Offices and Warehouses: 106 and 190, CANNON-STREET, LONDON.

AUGUSTUS WESTWOOD and Co., Mechanical, Telegraphic, and Gas Engineers, COMMERCIAL CHAMBERS, WEST BROMWICH.

The SCHOOL of SUBMARINE and MILITARY TELEGRAPHY, 4, GEORGE-STREET, HANOVER-SQUARE, LONDON, W.

DAVIS and TIMMINS, Screw Manufacturers, BOWLING GREEN-LANE, FARRINGDON-ROAD, E.C.

T. WIESENDANGER'S CLASSES in PRACTICAL SCIENCE.—Electricity and Magnetism on Thursdays, 7:30 to 8:30. Acoustics, Light, Heat, Thursdays 8:30 to 9:30. All Lectures are fully illustrated. Appliances for constructing apparatus.—33, New Bridge-street, Ludgate-circus.

TO ENGINEERS and Others.—The Managers of the Metropolitan Asylum District are prepared to receive TENDERS for the STEAM COOKING APPARATUS and FITTINGS of KITCHEN DEPARTMENT generally at the ASYLUM for IMBECILES, at Darenth, near Dartford, Kent.

Copies of plans and specifications, prepared by the architects, Messrs. A. and C. Harston, of 15, Leadenhall-street, E.C., may be obtained at the Offices of the Managers, 37, Norfolk-street, Strand, W.C., on and after Wednesday, the 26th inst., on payment of a deposit of five guineas, which will be returned to persons sending in *bonâ fide* Tenders and returning specification and plans.

Tenders (on a form which will be supplied) must be delivered at the said offices on or before Four o'clock on WEDNESDAY, the 10th December next.

The Managers do not bind themselves to accept the lowest or any Tender.

By order, W. F. JEBB, Clerk.

No. 37, Norfolk-street, Strand, W.C., Nov. 21, 1879.

ELECTRICAL AND EXPERIMENTAL APPARATUS.

MR. J. C. STEVENS has received instructions from the BRITISH TELEGRAPH MANUFACTORY COMPANY (LIMITED) to SELL by AUCTION, at his Great Rooms, 38, King-street, Covent Garden, on FRIDAY, December 5, at half-past 12 precisely, the STOCK, PLANS, MATERIALS, and INSTRUMENTS, belonging to some of their departments; they include many kinds of electric, telegraphic machines, and other scientific apparatus, and the implements and materials for making the same. Also many experimental and perfected instruments connected with the inventions of Wheatstone, Morse, Pelletier, which would be interesting and useful for colleges, museums, and lecture rooms. Gramme light and plating machines, lathes, tools, anvils, vices, wire, materials and chemicals for batteries, magnets, galvanometers, bridges, rheostats, A B C instruments, cyrtographs, calculating machines, electric clocks, magnets, bells and pulls, lightning dischargers, &c., &c. May be viewed after 2 o'clock the day prior and morning of sale, and catalogues had.

ELECTRIC LIGHT APPARATUS.—To be SOLD, together or separate, at a considerable reduction in price, TWO 6-LIGHT GRAMME ELECTRIC MACHINES, alternating current, TWELVE JABLOCHKOFF LAMPS, and other apparatus, in excellent condition. Have been used a very few nights.—Address X., care of MARTINEAU and SMITH, Birmingham.

TORPEDO APPARATUS

OF THE LATEST IMPROVED FORM, together with all necessary Materials, supplied by

Captain C. A. McEVOY, 18, ADAM STREET, ADELPHI, W.C.

ESTABLISHED 1851.

BIRKBECK BANK.—Current Accounts opened according to the usual practice of other Bankers, and Interest allowed on the minimum monthly balances. No commission charged for keeping Accounts.

The Bank also receives money on Deposit at Three and a Half per Cent. Interest, repayable on demand.

The Bank undertakes for its Customers, free of charge, the custody of Deeds, Writings, and other Securities and Valuables; the collection of Bills of Exchange, Dividends, and Coupons; and the purchase and sale of Stocks and Shares.

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A Pamphlet, with full particulars, on application.

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Southampton-buildings, Chancery-lane.

The Birkbeck Building Society's Annual Receipts exceed Four Millions.

HOW TO PURCHASE A HOUSE FOR TWO GUINEAS PER MONTH, with immediate Possession and no Rent to pay. Apply at the Office of the BIRKBECK BUILDING SOCIETY.

HOW TO PURCHASE A PLOT OF LAND FOR FIVE SHILLINGS PER MONTH, with immediate possession, either for Building or Gardening purposes. Apply at the Office of the BIRKBECK FREEHOLD LAND SOCIETY.

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THE ANGLO-AMERICAN TELEGRAPH COMPANY

(LIMITED),

IN CONNECTION WITH THE EXTENSIVE SYSTEMS OF

The WESTERN UNION TELEGRAPH COMPANY of AMERICA, and The MONTREAL TELEGRAPH COMPANY of CANADA.

DIRECT TRIPLICATE CABLE ROUTES

Between EUROPE and AMERICA, via Valentia, Ireland, and via Brest, France.

Telegrams accepted at any Post Office Telegraph Station in the United Kingdom, or at the Company's Offices,

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At which Senders, in order to save time, should hand their Messages DIRECT to the Company.

The name of the place from which Messages originate is transmitted, as a service instruction, FREE OF CHARGE.

Rates and other particulars may be obtained at any Post Office Telegraph Station, or at the following Agencies of the Company:—

LONDON	No. 23, THROGMORTON STREET.
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MANCHESTER	No. 20, BROWN STREET.
GLASGOW	No. 59, ST. VINCENT STREET.
PARIS	No. 28, RUE CAUMARTIN.

JOHN GRANT, *Secretary.*

General Offices of the Company, 26, Old Broad Street, London, E.C.

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SLIP

INSTRUCTION.—The *Foreman Engineer* states that a school of telephonic engineers or inspectors is now in process of formation in London.

REPORTING.—Modified forms of the microphone and telephone have been successfully used during Mr. Gladstone's recent speeches in Scotland.

CITY GUILDS INSTITUTE LECTURES.—By the permission of the lecturer (Prof. W. E. Ayrton) we hope shortly to commence the publication of the lectures delivered by him on electricity.

THE ELECTRIC LIGHT.—We understand that a new experiment in electric lighting has been lately tried in the works of Messrs. Siemens Brothers, at Passy, under the direction of M. Boistel, the engineer to the firm, from which results of some importance are anticipated.

ACTION OF LIGHT ON BATTERIES.—The Count du Moncel has pointed out to the French Academy of Sciences that the recent observations of M. Peltat on the behaviour of batteries in sunlight were made by him in 1872, and are described in the *Comptes Rendus* for Nov. 4 of that year.

AUTOMATIC ENGINE-ROOM TELEGRAPH.—Shaw's automatic telegraph for use at sea, to enable the officer on duty to direct the engineer direct from the "bridge," has been introduced into several steamships, by Mr. A. H. Colman, of Newcastle-on-Tyne. Its peculiar merit consists in the fact that the engine itself automatically informs the officer that his order has been obeyed.

THE CAVENDISH LABORATORY.—The Professorship of Experimental Physics, Cambridge, has been formally continued by the Senate, and there is now no doubt that if Lord Rayleigh is willing to undertake the onerous office of filling the chair now vacant by the death of Prof. Clerk Maxwell, he will be elected.

THE CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The number of messages passing over the lines of the Cuba Submarine Telegraph Company (Limited), during the month of November, was 2,772, estimated to produce £3,000, against 2,421 messages, producing £2,609 in the corresponding month of last year. The traffic receipt for the month of September, estimated at £3,000, realised £3,315.

EDISON'S TASIMETER.—Mr. R. A. Procter, in a letter discribing the collision of the Arizona with an iceberg, recalls attention to a suggested use of Edison's Tasimeter, namely, to warn sailors of the approach of icebergs. It will be remembered that the tasimeter is exceedingly sensitive to heat, and indicates increase or diminution of marvellously small quantities, hence its adaptation for such purposes as the one indicated.

THE TELEPHONE AT BIRMINGHAM.—Augustus Westwood and Co., telegraph engineers, of West Bromwich, have erected five lines of wire for Messrs. W. and T. Avery, Birmingham (the eminent scale makers), on which they are using Bell's telephone. The success of the instrument is so great that the firm are in treaty with Messrs. Westwood to erect a line of wire between their works at Birmingham and Ryder's-green, a distance of $10\frac{1}{4}$ miles.

CAST IRON MAGNETS.—These are made by M. Carré by melting soft metal very slightly carburetted in crucibles, adding 10 to 15 per cent. of steel filings, and running it into moulds. If 1 to $1\frac{1}{2}$ per cent. of nickel be added to the mixture, and 25 to 30-1000ths of copper, or 2 per cent. of tin, and 50-1000ths of copper, the moulded iron can be tempered at a cherry-red heat. The best result is obtained, however, by tempering pure cast iron at as high a temperature as the moulded pieces will stand without distortion or fracture.

SAVAGE TASTE.—The friends of gas-lighting in Paris have been making capital out of the fact that a semi-savage negro from French Guiana, on being asked whether the Jablochkoff electric candles or the ordinary gas lamps of the Avenue de l'Opera gave the brightest light, unhesitatingly pointed to the gas. This is probably the first instance on record of a negro having been employed as a photometer; and the decision in question must be as gratifying to the supporters of gas as Ketchwayo's appreciation of the bagpipes is to all patriotic Scotchmen.

BEACON BUOYS.—Buoys are important articles in submarine cable-laying, and it is interesting to note that an automatic whistling buoy is to be tried on the north-east corner of the Goodwin Sands. The whistle is blown by compressed air under the riding action of the waves. The Trinity House are also experimenting with buoys lit by Pintsch's gas made from vegetable refuse. Mr. Brasseur, a Belgian gentleman, recently patented in England a buoy, lit on the top by means of a vacuum tube and an induction coil, the primary current being derived from large battery plates immersed in the sea.

THE ANCIENTS AND ELECTRICAL KNOWLEDGE.—We have before us a long report of a lecture by Mr. G. F. Sargent at Nisch on magnetism and health. The lecture contains a good many historical statements that must have been gathered together with great labour. The lecturer states that electricity was known six hundred years before the commencement of our era. Its virtues, too, were recognised; for we are told in the year of Our Lord 10, by Scribonius Largus, an eminent Roman physician and author, that Anthero (a freeman of Tiberius) was cured of the gout by the shocks of a torpedo-fish—a thick, flat fish, found on the shores of the Mediterranean, and on the Atlantic coast of France.

THE ROYAL SOCIETY.—The President of the Royal Society in his anniversary address, mentioned certain difficulties that had arisen from time to time in the experimental illustration of papers, and to obviate these difficulties he offered the society a gas-engine of eight horse-power, which, in the opinion of those best able to judge, will be amply sufficient both for experimental illustration and for illumination. On hearing of this offer Dr. Siemens, F.R.S., immediately expressed his wish to add a pair of dynamo machines of improved construction (one for alternate, the other for direct currents). It was also stated that Dr. Siemens contemplated bringing the principle upon which these new machines are constructed before the notice of the society.

THE NEW FRANCO-AMERICAN CABLE.—The first messages transmitted by the new cable between Brest and Cape Cod were between the Presidents of the French Republic and of the United States. The former telegraphed—"Paris, 20 Novembre, 1879.—Le Président de la République Française inaugure le nouveau câble qui unit la France el l'Amérique en envoyant l'expression de ses sentiments les plus cordiaux à Monsieur le Président de la République des Etats-Unis." The following is the reply of President Hayes:—"Washington, Nov. 21, 1879.—The President of the United States has received with the greatest pleasure the agreeable communication in which the President of the French Republic announces

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the successful laying of the new Transatlantic cable. He hopes that this cable will be the means of transmitting only messages of friendship and respect between the Governments and the citizens of the two countries."

TELEGRAPHIC COMMUNICATION WITH THE FIRE BRIGADE STATION.—The House Committee of the Fulham Union reported at a late meeting of the Guardians that after consultation with Mr. T. B. Ascough, who attended at the committee's invitation from Mr. Preece, Electrician to the General Post Office, the committee found that the Post Office authorities were not disposed to give permission to erect a wire on the Government posts between the workhouse and the Fire Brigade Station, but were prepared to put up the wire themselves, and let it to the Guardians at an annual rental of £20, which sum would include a Wheatstone apparatus, and all necessary repairs. The committee did not at present recommend the Board to incur this expense, but suggested that the further consideration of the matter should be deferred until the return of General McMurdo, who had taken great interest in the proposal, and gone to some trouble in communicating with Mr. Preece.

A POWERFUL MAGNET.—An electro-magnet, capable of sustaining three tons dead weight, has been constructed in Indianopolis (Indiana), by Mr. Charles Reitz. It weighs, with all its attachments, about 800lb., and consists of two soft iron cores, each 30 inches long, and four inches in diameter, having rubber heads half inch thick and nine inches in diameter. The cores can be removed at will. The "yoke" is $3\frac{3}{4}$ inches thick, $6\frac{1}{2}$ inches wide, and 18 inches long, with three-inch slots to admit of removing the cores. The latter are wound with eight layers of No. 6 cotton-covered copper wire, wound double, the alternate layers being provided with terminals, which are connected with a plug switch on the base-board, so that the electric current may be sent through the coils in various ways. The magnet is provided with two sets of pole-extensions for diamagnetic experiments, one set being conical, the other flat. The armature is 15 inches long, three inches thick, and four inches wide.

THE INFLUENCE OF TERRESTRIAL MAGNETISM ON POLARISED LIGHT.—Those physicists who, following Arago, have studied atmospheric polarisation, notably Babinet and Brewster, have admitted that the plane of polarisation of the light sent by any point of the sky is perpendicular to a plane passing through the sun; but M. Henri Becquerel has succeeded in proving that this coincidence does not generally exist. His method of experimenting was to observe at each instant the trace on a divided circle of the plane of the sun, the plane passing through the eye of the observer, the point of the sky in question and the centre of the sun, and compare this trace with the trace of the plane of polarisation of the light sent in a direction perpendicular to the plane of the circle. For result he finds that there is a variable deviation between the plane of the sun and the plane of polarisation of the atmosphere at any point, and that the magnetism of the earth influences the atmosphere in this respect.

LIBERAL SOCIAL UNION.—At the meeting on Thursday evening, Nov. 26, held at St. George's Hall, Langham-place, Dr. W. B. Richardson gave an interesting account of Gray's first electric line. The lecturer, in the first place, described Gray's astronomical work, showing that he brought a mind of no mean order to the study of electrical problems. Soon after his becoming, in 1719, an inmate of the Charterhouse, we find him experimenting in electricity. This early work was graphically described, his want of tools depicted, the simple apparatus with which the experiments were made was indicated and illustrated; how he discovered the attractive power of a cork placed at one end of an excited glass tube, how from the cork he got to one length of a fishing-rod, then two lengths, and from that to a length of damp twine, finding the effects still the same. The action took place from the balcony to the ground below. Then we were told of his experiments at Otterden with Mr. Weaver; how the original experiments were successful, how the experiments in the large barn failed, and how failure led to new discoveries; and, lastly, the success of a line 700 feet long—the first electric line—was described. Gray's work is not very well known, and yet it was of an exceedingly interesting nature, and we thank the Liberal Social Union for directing attention to it by the admirable lecture of Dr. Richardson.

THE ELECTRIC LIGHT AT LIVERPOOL.—A discussion as to the value of the electric light used in the Picton Reading Room, Liverpool, took place at the meeting of the library committee on Thursday, the 20th inst. It being stated that £600 was due to the British Electric Light Company, Mr. D. Radcliffe asked if the electric light was suitable for the permanent lighting of the room. The borough engineer replied that he thought so, as it was by far the best application of the light he had yet seen. He was rather astonished that the company should have entered into an agreement with the corporation to provide the light so that it would be absolutely steady and free from noise. The light as now applied was undoubtedly a great success, quite as great as he expected, because he did not consider that absolute freedom from noise could be obtained. The chairman: I think it a success, and it is far superior to gas. The flickering may be reduced. Mr. P. H. Rathbone: I think it is the most successful application of the light that has been seen in any part of England to the present time. Mr. Radcliffe: Then there ought to be hesitation about paying the £600 to the company. The chairman: Are you prepared, Mr. Deacon (engineer), to give a certificate for the payment of this money? Mr. Deacon: Yes; but I do not think that the contract has been fully complied with.—A resolution was then passed sanctioning the payment.

DR. AGER AND TELEGRAPH CODES.—An editorial comment and a letter of Dr. Ager's both appear in the *Telegraphic Journal* of Dec. 1, evidently intended as an answer to our criticisms on this gentleman's method of publishing his code. We take it that an answer to a criticism, to be of any value, should appear in the columns of the publication in which the original remarks appeared. Why should Dr. Ager prefer to address an audience that knows nothing of what has previously been said? Does he think that conclusions are formed by hearing one side of the question only? We know nothing of Dr. Ager's agreement with the Eastern or any other company, but we do know that it would be idle to ask the keen business men who are connected with the telegraph companies to support with their influence a "code" of which they had examined but a very small portion. Dr. Ager admits in his letter that he "promised to submit to Sir James Anderson from time to time proofs of the code" in order that Sir James Anderson might be able to say he had seen it during its compilation. As a matter of fact proofs have not been submitted except to the extent of a few pages, and hence the contention that Dr. Ager has not fulfilled his part of the agreement. Other portions of the letter appear to us equally indefensible, but it seems needless to enter further into the subject, as Dr. Ager in the above remarks practically endorses the whole of our previous statement.

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THE LATE PROF. CLERK MAXWELL was in the habit of recreating his mind from its severer tasks by penning amusing physio-comic parodies of well-known poems. One of the best of these was his electric valentine, which runs as follows:—

ELECTRIC VALENTINE.

Telegraph Clerk A to Telegraph Clerk B.

"The tendrils of my soul are twined
With thine, though many a mile apart;
And thine in close-coiled circuits wind
Around the magnet of my heart.

"Constant as Daniell, strong as Grove;
Seething through all its depths, like Smee;
My heart pours forth its tide of love,
And all its circuits close in thee.

"O tell me, when along the line
From my full heart the message flows,
What currents are induced in thine?
One click from thee will end my woes."

Through many an Ohm the Weber flew
And clicked this answer back to me——
"*I am thy Farad staunch and true*
Charged *to a Volt with love for thee.*" $\frac{dp}{dt}$.

The inscrutable signature $\frac{dp}{dt}$ is explained by a correspondent in last week's *Engineering* to be adopted from the fundamental equation of thermodynamics $\frac{dp}{dt} = J.C.M.$ (James Clerk Maxwell). This explanation reminds us that the famous colleague physicists, Thomson and Tait, are familiarly known to their students as T and T, nicknames also drawn from the jargon of Thermodynamics.

THE TELEPHONE SETTLEMENT.—The rival and conflicting interests in the various telephone patents have at last been harmonised, and Professor Bell is master of the field. The stockholders of the National Bell Telephone Company met in this city yesterday, and ratified the compromise by which all matters in controversy were terminated. The Western Union Telegraph Company, acting for and on behalf of the Gold and Stock Telegraph Company, the American Speaking Telephone Company, and the Harmonic Telegraph Company, agrees to withdraw from the telephone business in the United States, leaving the field entirely clear to the company operating under the Bell patents. All persons who hold rights from other companies will be licensed under these patents. The Western Union further agrees to allow the Bell Telephone Company a percentage on the telegraphic business received through its instruments, and to co-operate to the extent of its power. Under this adjustment the Bell Telephone Company acquires all the telephonic inventions of Elisha Gray, of Chicago; of Thomas A. Edison, of George M. Phelps, and all others who had assigned their interests to the Western Union or other allied companies. The right to connect telephonic district or exchange systems remains exclusively with the Bell Company, which will also license the Western Union to use the telephone for transmitting telegraphic messages. The compromise thus not only secures freedom from litigation and control of all the patents now out for the purpose of transmitting human speech, but establishes harmony of interests between the Western Union and the new company, which must be of inestimable value to both.—*Boston Daily Advertiser*, Oct. 25.

TELEGRAMS AS LEGAL NOTICES.—In these days, says *Capital and Labour*, when the telegraph wires are so largely used for the conveyance of messages, the question whether a formal legal notice can be sent by telegram is both interesting and important. This point has just been raised in the Court of Appeal before Lords Justices James and Thesiger, in a case arising out of the following circumstances:—An officer of the Sheriff of Kent took possession of a hotel at Deal on a judgment which had been obtained against the proprietor. The sale under this judgment was to have taken place on August 5, but on the debtor promising to pay out the execution, the sale was postponed till August 6. On the morning of the latter day further representations that the debtor would pay were made, and the auctioneer postponed the sale for an hour, at the expiration of which it proceeded. After a few lots had been sold, a telegram was received from a firm of London solicitors giving notice to the Sheriff's Officer in possession that the London Court of Bankruptcy had made an order restraining the sale and stopping further proceedings against the debtor. Now, it so happened that the man then in possession was not the Sheriff's Officer, but the deputy of the Sheriff's Officer, Mr. E. A. Smith, who had that morning gone to Canterbury on other business. On receipt of the notice from London the deputy telegraphed to Mr. Smith for instructions, the sale being meanwhile again postponed. Mr. Smith replied that the sale should be proceeded with if the telegram did not state that the debtor had paid money or filed his petition. Mr. Langley, the auctioneer, then went on with the sale. Now, the debtor really had filed his petition before the telegram was sent. The Chief Judge in Bankruptcy, who held that the telegram constituted proper notice, accordingly committed both Mr. Smith and Mr. Langley for contempt of court. Against this committal they appealed, contending they believed the telegram to be a ruse. Lords Justices James and Thesiger, in reversing the order of commital, considered that the previous promises justified suspicion that the telegram was a ruse. Lord Justice James was "very far from saying that notice of an order could not be given by telegram. But it would be very difficult to commit a man for disobedience to an order of which he had notice only in that way, when he swore positively that he did not believe any order had been made, and there was that which gave colour to his story." His lordship added that the proper course would, in his opinion, be for a solicitor in London who had obtained such an injunction, to telegraph to a solicitor at the place in the country, directing him as his agent to give notice of the order there. Lord Justice Thesiger "did not dissent from the proposition that the Chief Judge in Bankruptcy had laid down, that in certain circumstances notice of injunction by telegram would be sufficient, so as to make the person who disobeyed the order liable to be committed for contempt. It would be most disastrous to the purposes of justice if means of communication by telegraph could not be employed. The question in each case was whether such notice had been given as that you could reasonably infer that the person affected had had actual notice." The *onus* of proof that there had been such a notice was on those who asserted that there had been; but his lordship thought that *onus* had not been discharged in the present case, for there was nothing to show Smith that any proceedings in bankruptcy had been taken. From these opinions it would appear that telegrams may "under certain circumstances" constitute a notice of an order of Court, but it rests with the judges to decide what are the circumstances, and each case must be dealt with on its merits. As a telegram can never be in the handwriting of the sender, nor bear, like a letter, his particular heading, seal, or crest, it is obviously so much easier to forge the one than the other; and so difficult to tell whether a telegram is genuine or not, that it is highly improbable the last has been heard of the important question, how far telegrams can be accepted as formal notices.

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CANTOR LECTURES.*

RECENT ADVANCES IN TELEGRAPHY.

By W. H. PREECE, Electrician to the General Post Office.

LECTURE IV.

(Delivered May 12th.)

DUPLEX AND QUADRUPLEX TELEGRAPHY.

I commence a rather difficult task to-night, and that is to endeavour to make an audience comprehend the operation of conducting telegraphy on one wire, so as to transmit four messages at the same time. Such an operation is called quadruplex telegraphy, and quadruplex telegraphy depends upon two separate and distinct operations. One is the power to transmit two messages at the same time in the opposite direction, which is called duplex telegraphy; and the other is the power of transmitting two messages in the same direction at the same time, and that is called diplex telegraphy. So I perplex you with several "plexes." In the first place we have simplex telegraphy, which you saw last time. Now we have duplex, diplex, and quadruplex; and all other kinds, beyond quadruplex, of sending messages, are called multiplex.

Time to-night will not allow me to go absolutely into all the details of these operations, but there are many books in different languages that enter into the matter very fully, so that those who are interested in it may pursue it still further. Besides the books published in England there is a very complete one published in America by Mr. Prescott, the electrician to the Western Union Telegraph Company, that goes very fully into the history of the process. Then, in France, we have a capital work by Count Du Moncel. In Germany we have two excellent works by Professors Zetche and Schellen.

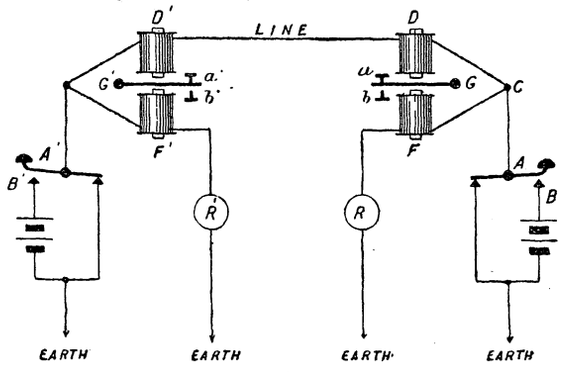
There are many means of carrying out these different processes, but in order to be quite clear, I will confine myself to-night simply to one. Last time I showed you how simplex telegraphy was carried on by sound. The mere taps produced by the armature of an electro-magnet produced sounds, and from these sounds we were able to produce the Morse alphabet. [Several letters were sent on a sounder.] These sounds are produced by currents of electricity passing round a core of iron, converting that iron into an electro-magnet, and thereby causing the attraction of a mass of metal. Currents of electricity vary in two ways; firstly, they can flow from here to Liverpool, say; or they flow in the other direction. So that their direction varies, and according to their variation in their direction, so will they produce polarity in an electro-magnet. For instance, here I have an electro-magnet, and suspended above it is a needle, which, when the current goes in one way, is attracted on one side, and when the current goes in the other way is attracted to the other side. You see when I press this key down I cause a current to go in one direction, and by just a simple reversal I am able to cause that magnet to be attracted in the other direction. I do that in this way. This electro-magnet is wound with two separate and distinct wires. When the current goes through one wire it sends this needle (a long needle attached to the armature of the electro-magnet) over on one side; and when the current goes through the other wire it sends the needle over in the other direction. Currents of electricity invariably divide themselves through any number of paths that are left open to them, exactly in proportion to the obstruction or resistance as it is called, which the wire offers to the current. If I bring my key down now, the current which I am sending from the battery below me divides between two wires of unequal resistance. The strong current goes in one direction, causing the needle to be deflected in one way. If I weaken the current going through the one wire, and strengthen the other, then I cause the needle to go on the other side. Now, the first thing that I have to do to enable me to work duplex, is so to let these two currents pass through my instrument that they shall exactly neutralise each other. That is, that the current which goes in one direction shall be of exactly the same strength as the one which goes in the other direction. Here I have a little bobbin of wire that represents my line (you may conceive it, if you like, to be a wire extending from here to the Central Station), and here I have what is called a rheostat, an instrument which gives me exactly the same quantity of wire; it exactly represents a line, and is, in fact, an artificial line. Now, I know that the current going through one wire is very much stronger than the current going through the other wire, and by making this artificial line equal to the actual line we shall get the two currents of exactly the same strength. [This was shown on the electro-magnet].

You will see that there is absolutely no effect whatever upon the needle. If I increase this line, at once you see the balance is disturbed; if, on the other hand, I increase the other line, you will also see that it is disturbed; and when I make my two lines of exactly equal length electrically, you will find no current whatever goes through. At the present moment, assuming that our little bobbin there were an instrument like this little sounder at the other end of it, every time I tap my key here currents pass through this instrument without affecting it, but they affect the one at the other end. If, by any means, while I am tapping, any disturbance of the line takes place, you see at once we get an indication of it. There are those two facts that I want you to bear in mind. First, the currents divide themselves exactly in proportion to the resistance opposed to their progress; secondly, by taking advantage of that, we can so equalise the effect upon a magnet as to produce a complete neutrality. I want you to bear this in mind, because the usual notion of duplex telegraphy consists in imagining that there is something that passes or crosses; some such idea as two trains, running in opposite directions upon one line, passing each other in some way or other.

In this process of duplex telegraphy, there is nothing that passes; it is a case of neutrality. The currents flowing in opposite directions neutralise each other, and it is the advantage that is taken of this neutralisation that is made use of to produce telegraphic sounds and telegraphic alphabets. To assist you thoroughly in bearing this in mind, I am obliged to make use of a diagram; and it is rather a difficult thing for those who are not in the habit of examining diagrams of apparatus and circuits to follow exactly what takes place.

* From the *Journal of the Society of Arts* for October, 1879.

Here I have a diagram representing a circuit fitted up in duplex (Fig. 8). This series of thick and thin lines represent a battery, the thin line always representing the copper, the thick line the zinc of an ordinary battery. The same at the other end. The line wire you may imagine to be of any length, say 100 miles. This diagram shows the portion of the apparatus in London, as also the portion of the apparatus, say, at Birmingham.



DUPLEX SYSTEM

A is the key, similar to the one I have here. It is an ordinary key, that simply brings the two points, A and B, in contact, and causes the current to flow from the battery, the other end of the battery being in connection with the earth, E. When the key A is depressed, the lever comes into contact with B, and causes the current from the battery to flow. The current flows through the key A to point C, whence it has two paths open to its progress. If the resistance of the two paths be exactly equal to each other, then the current that flows in each of the two branches is exactly the same. We will assume that the paths are exactly equal to each other, and, therefore, the current flowing through is exactly the same. One half the current flows along the upper branch, round the coil D, and converts it for the time being into an electro-magnet, which attracts or repels, as the case may be, the tongue G. When the tongue G is moved it comes over and makes contact at *a*. The current, as I say, passes through coil D, and then along the line wire to the coil D^1, in passing through which it attracts or repels, as the case may be, the tongue G^1; from there it goes to the key A^1, and from the key A^1 it goes direct to the earth; so that, you see, one half of the current from this battery goes through the electro-magnet D through the line, through the other electro-magnet D^1 to the earth at the other end, and as it does so it causes the tongue there to work, and the tongue of this relay completes a local circuit, which I have not shown upon the diagram because it makes the diagram much more confusing. The last time I had before you a diagram showing how relays were connected up with sounders, and how they caused the latter to work. This tongue in moving causes a sounder to work so far as regards the upper magnet.

Now let us take the lower half. The current, as I have said, divides at C, half going to line, the other half going from C to F, through the coil F, through the artificial line which is marked R (this is, in reality, precisely similar to that which I had in my hand, and represents an artificial line that we can vary from 1 mile up to 1,000 miles), and to earth. Now, then, you will see that every time this key A works, the current is split into two parts of exactly equal strength, the one pulling the tongue in the one direction, and the other pulling the tongue in the reverse direction, the effect being, as in the present case, when it is acted upon by currents of exact strength in opposite directions, simply *nil*. Therefore, every time we move our key we have no effect upon our instrument here, but the current through the line passing the electro-magnet D^1 and going to earth is not opposed to an equal and opposite current, hence it acts upon the tongue, G^1, and, therefore, makes sounds or marks at the distant station. Therefore, every time we depress the key A, the current passes through our instrument without affecting it, and dots and dashes represented by the depressions are made at Birmingham.

That is the first operation. Now let us take the other one. Birmingham is working to London. He depresses his key N^1, causing currents to flow from his battery as in the home station. The currents divide at C^1, one half goes through the coil D^1 to London, works London's coil, D, and so to earth, and back again to the sending battery. The other half flows through the coil, F^1, acts upon the tongue, G^1, in the opposite and reverse direction, and passing through the artificial line, R^1, comes back to the battery. Therefore, when Birmingham works to London, Birmingham also sends his currents through his own instrument, but they are neutralised there, and produce no effect; they proceed along the line to London, work London's instrument, which records the dots and dashes sent. So that you see we have, first of all, London working to Birmingham alone, next, we have Birmingham working to London alone.

Now, we want to see what happens when London is working to Birmingham at the same time that Birmingham is working to London.

Well, when you send a current along a wire—let my rod, for instance, represent a wire, and a current is sent from my right hand to my left hand in one direction, and at the same moment I send a current from my left hand in the other direction, if these currents are of exactly the same strength, they neutralise each other, and the result is that you get no current over your wire at all. So, if I sent a current from London to Birmingham, and at the same time a current is sent from Birmingham to London in the other direction, the result is that no current at all is received, and we get no magnetism. But the other half of the current in each case that passes through the coils, F and F^1, acts on the tongues, G and G^1, and attracts them to their respective stops, *b* and b^1, causing marks or sounds to be made. And just in the same way at Birmingham, when Birmingham's current is neutralised by that from London, the second half of Birmingham's current is allowed to act on the coil F^1, and pulls down the tongue G^1, and the result is that while London is working to Birmingham, the instrument at Birmingham continues to mark, and when Birmingham is

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working to London, the instrument at London continues to mark, so that really the marks that are made in London are by London's own current, and those made in Birmingham are made by Birmingham's own current. Just watch the process. Suppose by pressing the key A down I send a dot, my current divides at C, one-half goes through D, the other half through F, they are neutralised, and we get no effect at all. If, however, at that same moment Birmingham were sending a dot to me, my half through D would be neutralised, and I should get the dot, because the second half of the current through F would work, and the dot, although it is made by my own current and by my own key, is actually the representative of the dot that would have come from Birmingham, but which is neutralised and lost on the line, as it were. Just in the same way, while Birmingham is sending his dot to me, his half of the current through D^1 going along the line is lost and neutralised, but the other half going through F^1 is allowed to operate, and Birmingham also has his dot. So that you see, while London and Birmingham are working together, whether sending dots or dashes, or combinations of the two, the signals are recorded by the second half of the currents sent, just as though the current came all tbe way from the sending station.

I have said that the currents exactly neutralise each other. That is upon the assumption that the line itself is absolutely perfect, that is, that the insulation is perfectly good, when no current is lost, and the two currents in opposite directions are exactly neutralised. But that is not necessary nor essential. We cannot get lines, in this country at any rate, whatever they may do in others, perfect. Occasionally, as you know, we have a little rain. Sometimes we have fog, and there are other disturbances that interfere to a certain extent with the true insulation of our lines, and the result is that the currents that arrive at a distant station are not so strong as those that leave the home station. But it does not matter in duplex working, if you do not get absolute neutrality you get a difference between the two. If you balance your coil as I have done here, and have absolute neutrality, then if a current came from the distant station, the effect on this would be the difference of the two currents, and that might produce a very small deflection on this large needle, but it would produce a current strong enough to work the relay. And the curious thing is this, that whatever be the strength of the current arriving in London from Birmingham, whether it be equal or smaller than the current going out, the tongue of the relay is governed or moved by the difference between those two currents, and the difference between those two currents is always the strength of the received current. The tongue of your relay is always worked by the same force, whether that force be due to a received current, or whether it be due to the difference between the two currents, the one going through the upper half, and the other through the lower half. Hence, practically, insulation does not interfere to any great extent. Still, when insulation becomes very bad in very bad weather, we have differences that render it difficult to work duplex; but when it is difficult to work duplex from such a cause, it is often also difficult to work simplex, and, as a rule, we find that as long as we can work our lines simplex, so long are we able to work duplex.

I have given you a slight idea of how duplex is worked, but perhaps you will get a better knowledge from seeing the actual process itself. We have the same wire brought into this room that was brought into it last week, and we have apparatus fitted here similar to that at T S (Central Telegraph Station). Every station throughout the country (as I told you last week) has its code.

We are now "calling up" T S, and there you hear his acknowledgment. We now ask T S to send some news to us, and while Mr. Cooper is writing out that news as it comes, Mr. Chapman will at the same time be sending something to T S. Now, you see while Mr. Chapman is sending to T S, his instrument is not affected in the least. The currents are being divided through a relay, just as shown on the diagram, and produce no disturbance whatever, but every time that T S is sending to us you find that marks are being made, at one time with his own current, at another with that portion of the additional current that I showed you acts upon the other side of the relay. [An extract from a meteorological wind and weather report received from T S was read out.]

This operation which you see going on between here and T S, is identically the same as would go on when speaking to Liverpool or Glasgow. It is a very curious thing how space seems absolutely annihilated with telegraphic instruments, and how a telegraphist feels himself in all parts of the world at the same time. Here we are in this room and hear what T S is speaking to us, and in like manner if we were speaking to Liverpool (L V) we could fancy ourselves there also.

In order to make the news we are about to receive from T S heard all over the room, I will take off the simple tapper, and will use one of Mr. Theiler's new sounders, which he has been kind enough to supply me with. It will buzz at the signals in a loud musical tone.

[T S is asked to send V's, a succession of signals representing the etter V.]

I may tell you that these instruments have never been used before. We are trying a very risky experiment before your very eyes, and it is rather a difficult task to adjust apparatus and make things go before so many critical eyes.

[T S sends V's - - - ——— - - - ——— - - -.]

I may tell you that Mr. Cooper has never read by this instrument before.

(TO BE CONTINUED.)

CABLE COMPANIES.

We quote from *The Times* an important letter, together with the comments of that journal, on a subject which has previously engaged attention in our columns :—

The question raised in the following letter is of great importance to the holders of Telegraph Cable Companies' shares in this country. It is well known that much of the "extension" as well as of the manufacture of competitive lines which goes on is not primarily with a view to profit shareholders in these companies or the public, but the fact that this is the case increases rather than lessens the difficulty which lies in the way of Government interference. We believe, therefore, that should no *modus vivendi* be possible for the rival companies now possessing lines across the Atlantic, they must just be allowed to fight the battle out between themselves till the weakest goes to the wall. The French public has not invested in the French Cable Company's shares, and if the syndicate holding them chooses to ruin itself in competing with the English lines we hardly see why any Government should be called on to interfere to prevent that or any other consummation :—

SIR : The subjoined table, showing the present position and market value of all English cable companies, would seem to teach a lesson to investors in cable shares. The only company at a premium is the Submarine, which is protected by a special concession against competition. Considering the depreciated value of all other companies and their very moderate dividends for the great risks inseparable from cable property, it may well be doubted whether British money could again be obtained for new cables unless the Governments of those countries affected were to do the same for submarine cables which they did long ago, and from necessity, for the land lines, viz., take them over for Government account and prohibit all private competition

The history of the last new Atlantic cable (the Direct United States Cable) is not forgotten. *The Times* duly cautioned the public not to invest in this operation, which was characterised as of a highly speculative nature, and the result was that the promoters and contractors were left with nearly the whole of the shares. No dividend was paid for several years, and the shares dropped from £20 to £7, never improving until the shareholders made a satisfactory arrangement with the Anglo-American Company, thereby obtaining the security of four cables, and a fair proportion of receipts. Why French financial companies should have supplied the money for another Atlantic cable, looking at the quotation of about 50 per cent. discount of the old and well-established Atlantic cable companies, does certainly appear somewhat marvellous and beyond ordinary commercial comprehension. Why should the result be different from that of the Direct United States cable? In the meantime English shareholders will again have to suffer from excessive and uncalled-for competition calculated to injure cable property still further, and it does seem necessary that they should jointly take steps to obtain from the Government fair protection of their property. Shareholders of the various cable companies should form an association with this object. Submarine cables might easily be declared neutral property by international law, and a central international office in London might manage cables very successfully. The International Telegraph Bureau at Berne might bring about the necessary understanding between the several Governments. The total nominal capital of British companies amounts to £23,500,000, and the gross receipts per annum to about £2,210,000; there is a fair prospect, therefore, for Governments to negotiate the taking over of most or all the cables on a profitable basis, leading gradually to a reduced tariff.

Your obedient servant,
CABLE INVESTOR.

LIST OF BRITISH SUBMARINE CABLE COMPANIES.

TITLES.	Capital. Ordinary.	Debentures.	Preference Stocks or Shares.	TOTAL.
	£	£	£	£
Anglo-American Ordinary	3,254,580	—	1,872,710	7,000,000
" Deferred	1,872,710	—	—	
Direct United States	1,300,000	—	—	1,300,000
Brazilian Submarine	1,300,000	—	—	1,300,000
Eastern	3,697,000	682,000	700,000	5,079,000
Eastern Extension	1,997,500	320,000	—	2,317,500
Great Northern	1,500,000	—	—	1,500,000
Western and Brazilian	1,398,200	290,490	—	1,688,690
Cuba Company	160,000	—	60,000	220,000
Direct Spanish	116,379	—	58,430	174,809
German Union Trust	198,500	—	—	198,500
Platino Brazileiro	395,708	100,000	—	495,708
Submarine	338,225	—	—	338,225
West India and Panama..	883,210	14,200	392,320	1,289,730
Mediterranean Extension.	120,000	—	32,000	152,000
West Coast of America	300,000	—	130,200	430,200
Total				£23,484,362

TITLES.	Cable Mileage.	Revenue per Annum.	Percentage of Dividend on Ord. Capital.	Reserve.	Market Price £ per Cent.
		£		£	
Anglo-American Ordinary	12,272	536,000	6	500,000	56
" Deferred	—	—	—	—	—
Direct United States	2,900	180,000	5	100,000	50
Brazilian Submarine	3,667	140,000	5	160,000	73
Eastern	14,716	450,000	5	155,672	82½
Eastern Extension	7,429	260,000	5	30,905	85
Great Northern	4,297	198,000	6⅜	85,542	85
Western and Brazilian	3,775	122,000	Nil	—	21
Cuba Company	942	34,000	6	18,000	82½
Direct Spanish	781	12,000	Nil	1,097	20
German Union Trust	224	12,858	5¾	9,693	77½
Platino Brazileiro	1,258	23,000	1¼	6,142	25
Submarine	609	120,000	17	63,950	235
West India and Panama	5,306	82,000	1	21,000	15
Mediterranean Extension	204	10,978	3	11,234	30
West Coast of America	1,690	30,000	Nil	5,000	12½
Total		£2,210,836			

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OUR POSTAL TELEGRAPHS.

To appreciate fully the rate at which telegraphic engineering has advanced in this country, it is necessary and interesting occasionally to note and contrast the state of telegraphs at their earliest date, a few years ago, and at present. The interesting biography of the late Sir William Cooke, by Mr. L. Clark—the first part of which has just appeared in the *Journal of Telegraph Engineers*—supplies us with many interesting particulars of the early and earnest work of Sir William Cooke and Sir Charles Wheatstone. We find that their patent was sealed on June 12, 1837, and in July various experiments on wires between Camden and Euston were carried out; Mr. Robert Stephenson having taken an interest in the matter, and obtained for them the use of a large building at Euston. On July 24, 1837, experiments were made between Euston-square and Camden Town "through nineteen miles of wire," and from that time we may pass to 1846, when we have the Electric Telegraph Company incorporated, and their office in Founders-court established. The company outgrew these premises, and moved in 1859 to larger premises in Telegraph-street, Moorgate-street, and in 1867 we find they had 9,740 miles of line and 47,572 miles of wire, with 9,000 Daniell elements in the central station. The pneumatic despatch from the central station extended to the Stock Exchange, Cornhill, Founders-court, Leadenhall-street, Broad-street, Mincing-lane, and the Magnetic Telegraph Office, in all 3,580 yards in length, and these were worked by a 20 h.-p. engine. They had also cables to the Hague and Ireland.

Coming to the present day, the central station of the Post Office alone, in its imposing appearance and admirable arrangements, is well worth inspection and seems to show at a glance the rapid increase in the *personnel* and material since 1867. The large instrument gallery on the upper floor, with its army of lady clerks, its huge terminal board, long array of pneumatic tubes constantly disgorging packets of messages, and the clicking and working of hundreds of instruments is a sight which, after reading accounts of Cooke and Wheatstone's early experiments, cannot fail to impress the spectator with a feeling of pride and astonishment at the rapid advance of telegraphy.

Below in the cellars at the basement of the building are the batteries, arranged in tiers and tiers along passages that seem almost endless. The Muirhead form of Daniell, the Leclanché, and the Fuller batteries, are employed.

The lines of the postal system are partly maintained by the railway companies, to the extent of 10,427 miles of line, and 47,099 miles of wire, and along the roads and canals by the Post Office staff, to the extent of 14,016 miles of line and 63,081 miles of wire, exclusive of submarine cables. The total length of underground wires consists of 548½ miles of line, consisting of 9,216 miles of wire. There are 51 submarine cables proper, and 57 cables crossing rivers, canals, &c., having a total length of 1,229 miles of line and 3,829 miles of wire. To maintain this great number of submarine cables, the Post Office have no regular repairing ship. Her Majesty's Government is, in fact, the only administration in the world having submarine cables to maintain who have not a special ship for this purpose; nor have they any regular and proper store and yard, with tanks of their own. Woolwich Dockyard, one would have thought, could have found a home for one of the most important departments in the country, on which depends our telegraphic communication with Ireland and many other places; but it appears that the War Department greedily absorbs the whole of the vast space cast off by the Admiralty, and cannot spare a corner for the Post Office. One would think that the department which has to serve the public and Government hourly all through the year should, at least, be considered as much as a department whose torpedoes have never yet been called into play, and may not be for years. It seems to the unprejudiced eye like slighting and neglecting a daily requirement to provide with extra care for a remote contingency. In the matter of the security of the submarine system, therefore, the Government have made a decided retrograde movement, for the Electric Telegraph Company had both a ship and stores of their own.

It is not merely by the actual length of line, or even of wire employed, that we can justly estimate the magnitude of our postal telegraphs, for many of the circuits are, of course,

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short. There are now employed 3,541 single-needle instruments, 1,324 Morse, and 151 Wheatstone automatic, 260 Bells, 1,572 Sounders, 10 Quadruplex, 53 Translators, 4,916 A B C's, 22 Telephones, and 248 others of various descriptions. These include all the instruments used on private wires which are rented from the Post Office, which are principally A B C's and Telephones, the total being 12,097 instruments. The Hughes has been abandoned. The longest circuit is to Aberdeen, 543 miles. The average speed is by Morse 30, by single needle 25, and by automatic 100 words a minute. The pneumatic tube system is established in London, Liverpool, Manchester, Birmingham, Glasgow, Newcastle, and Dublin, in all 26¼ miles. In London alone there are twenty-two separate circuits of pneumatic tube, comprising 19 miles 1,509 yards of pipe, worked by two 50-horse engines, a third of the same power being kept in reserve in case of repairs to the others being required. The staff engaged, including engineering staff, clerks, messengers, &c., amounted at the end of last year to 11,448, and of these the electrical and engineering staff amounts to 650.

The principal advance that has been made of late years consists in the Wheatstone automatic, duplex and quadruplex, and also in increasing the speed on circuits where submarine cables intervene, by placing fast-speed relays at each end of every cable. The overhead lines are being rapidly removed and subterranean lines placed in their stead, and up to the end of last year 380 miles had been changed.

The total number of messages forwarded last year was 24,459,613, of which 11,240,609 passed through London. Besides this, 286 millions of words of news were delivered in the course of the year. There can be no question that the whole department has been exceedingly well organised, and is working well and with very little friction, and its efficiency does credit to the whole staff.

The question of how far the extension of the use of the telephone by companies with subscribers and central rooms will interfere with the rights of monopoly granted by Parliament to the Government is an interesting point, which must sooner or later grow to a head, and be settled by the law courts. At present it seems that the telephone companies, however, are putting up overhead lines in London, just as the Post Office (in response to an outcry from the public on account of their danger) has been removing them.

PRACTICAL PAPERS BY PRACTICAL MEN.

ELECTRIC BELLS.

BY W. MOSELEY.

(CONTINUED FROM PAGE 20.)

We will here, with the assistance of the following diagram, endeavour to deal with all the questions connected with the origin and prevention of all such faults as those mentioned, besides a number of correlative faults and failures, that have been frequently met with.

In any galvanic battery the electricity generated by the dissolution of zinc in an acid solution is collected at the positive pole, whether it be copper, carbon, platinum, silver, &c. When wires are connected to the two poles and extended away from the battery, then the generated current, travelling along the wire connected to C in the direction of the arrows, only awaits the offer of *any kind* or degree of conducting medium in order to return to the pole Z.

We prefer and strongly advise this view of the battery operation through wires, &c., because its bearing upon many practical effects are so frequently forgotten.

PART II.

In our previous remarks we have endeavoured to show up the evil and inconvenience of the past and present practice very generally adopted in fixing insulated wires in houses, &c. The various faults supposed to have occurred in one house are a fair example of the trouble and expense incurred by refusing to adopt safer methods of insulating and fixing the wires. The average wear and tear causes far greater expense than would be incurred by the adoption of a more perfect system of insulation in the first instance. Before going on to lay bare other weak points in the customary methods, let us here state emphatically that it is only misleading to refer to a few instances of perfect success in the use of the methods we now strongly condemn. We will not say that such instances are "more by good luck than good management," for the exercise of great care, foresight, and skill will do wonders; but there is one evil that frequently turns up to frustrate every care and the greatest skill—that evil is the fatal humidity of our climate. It is true some light has dawned upon some of our practical electricians, for "where dampness is *inevitable* special precautions are taken against it," but where it *may not* be damp no precautions are taken. We might here quote with great fitness the paradox, "It is the unexpected that happens;" for whatever may be the circumstances that would forbid any *expectation* of dampness, we cannot imagine any building in this country being at *all times damp proof* in the sense necessary to secure ordinary insulated wires, fixed in the ordinary way, from its ill effects.

We might refer to such a building as the Grand Hotel at Scarborough, perhaps the most perfectly successful electric bell plant in the kingdom, and certainly the most extensive and complete illustration, as regards the quantity of wire fixed, and the absence of all mechanical aids, where some dare not trust electricity.

But we can only refer to it for examples of the numerous and varied precautions that were adopted in spite of its great dryness before the wires were fixed. It must also be admitted that its almost constant occupation from its opening twelve years ago has lessened the severity of the test to which it would otherwise have been subject if it had not been constantly warmed. If, however, such an extensive ramification of wires were fitted in what we are bound to call still the ordinary method it would have been as great a failure as it is a success.

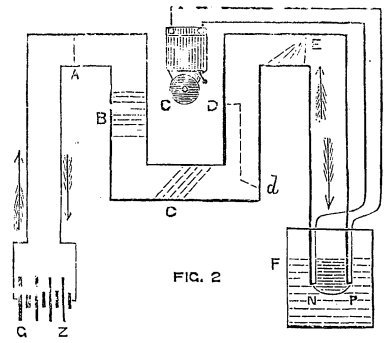

FIG. 2

It is not, therefore, in consequence of ignorance of some important examples of great success that we feel obliged to insist upon a somewhat systematic departure from the ordinary method.

It is also the result of very many and varied opportunities for studying the *effects* of faulty design and work that has enabled us, not to discover any new principle, but to learn that all bad effects are traceable to simple details ill-adapted to resist the encroachment of a subtle, ever-watchful enemy.

It appears also that, even where this common enemy is known, feared, denounced, and would be circumvented, there is no consistency or proportion of the varied means to attain the desired end.

We will not enter upon any consideration of the origin of the confusion of ideas that exists in relation to this phase of the question, for it would read like a chapter in mental philosophy. Let us endeavour, then, to explain what are the practical elements of the problem.

In any galvanic battery the electricity generated by the dissolution of zinc in an acid solution is collected at the positive pole, whether it be copper, carbon, platinum, silver, &c.

When wires are connected to the two poles and extended away from the battery then the generated current, travelling along the wire connected to C (Fig. 2) in the direction of the arrows, only awaits the offer of any kind or degree of conducting medium in order to return to the pole Z. It is true that on a lecture table it would be a proper statement to say that if two short wires were connected to the poles C and Z, and the two ends connected together, the battery would be short circuited, and the current travelling from pole C to Z outside the battery by such a short unresisting medium would excite in the battery, at the pole Z, as strong a current as the fluid would conduct and the pole C could collect or, in other words, the short circuit would

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excite the battery to its utmost capacity, so that a Leclanché battery would be exhausted in, say a week, and a Daniell in, say a month. But if the ends of the wires from C and Z were not connected either to each other or to any other conducting medium, then the Leclanché battery would not be exhausted in eighteen months, nor the Daniell in six months. But suppose the demonstrator were to wet a finger and thumb of each hand and take hold of the two bare ends of the two wires, then there would be a constant passage of the current through the body, and a consequent excitement of the battery, however slight that might be, as long as the wires were held in the fingers. We will now endeavour to group together, under five heads, the various exhibitions of this battery action, when applied to wires "permanently" fixed.

C—Z being the battery, F a vessel containing water, and G a trembling bell, two "covered" wires are connected to the battery, and the portion of each that dips into the water is stripped of its covering, the ends being connected to the bell G. As soon as the connections are completed the bell begins ringing. A portion of the current travels through the bell, and another portion through the water in F from P to N. Now, it is an open question, dependent only upon the nature and proportion of the relative parts, whether the bell will first cease ringing by the exhaustion of the battery or the dissolution of the positive wire at P in F. If the wires at N and P in F are wide apart, and in pure water, and the conducting wires from C through the bell back to Z offer little resistance, then the battery will be exhausted long before the wire will be dissolved in F, but the battery being renewed several times the wire at P in F will be either completely dissolved or will separate near the liquid surface before complete dissolution takes place. As soon as this separation takes place the bell will cease to ring. Meanwhile there are various portions of the covered wires that, through imperfections in the covering material and surrounding dampness, divert a small percentage of the current, which returns by a shorter circuit than if it travelled on to F or G, so that eventually, after the battery has been repeatedly recharged and the rupture or dissolution of the wire loop dipping into F has been "made good" again, then will come a rupture of the positive wire at A B C D or E.

Now, so far as the illustration goes at present, it will serve as an extreme example of incessant activity in a busy public telegraph line. The bell incessantly ringing will represent the telegraph instruments kept in almost constant activity by the pressure of public business. The losses of galvanic current force at A B C D E F, whatever may be the amount of loss, are overborne by extra battery power, as weather and other circumstances require. We shall presently have to deal more or less in detail with all the points referred to; but let us point out that it is desirable to mark emphatically—for several reasons—that up to this point we have a brief epitome of the question of public telegraph "wear and tear." Other matters, however, involving the *whole question*, have to be mastered and dealt with by whomsoever undertakes to set up successfully any important system of wire permanently fixed in buildings. It will be useful, therefore, to study the point of divergence. In public telegraphy, or outdoor telegraphy, whether from house to house, town to town, or nation to nation, when the whole apparatus is in a normal state of quiescence there is a break in the continuity of the conductor that is attached to the positive pole C at some point very near the battery, the position wire being separated by a switch, or some kind of contactor between the battery pole C and the imaginary fault at A; whereas, in private telegraphy, where there is a complete plant of wires and instruments permanently fixed in one building, the positive wire is separated by one or more of some kinds of contactors at some point between the vessel F and the bell G. We urge upon all, whether they think they know all about it, or are eager to learn, to carefully consider this point, and to review the preceding statements bearing upon this illustration. They will then scarcely fail to see the importance of the following elucidation.

Without the separation of the positive wire between the battery and the imaginary point A the completeness of the conductor to and from the bell G minifies the action of the current at the faults A B C D E F, and when the positive wire is separated between the battery and the point A the action of the battery current outside the battery is completely checked, and the wear and tear of the conductor at the six imaginary points is completely stopped. But when the positive wire is separated between F and G, as in the use of private electric bell plant, the whole force of the current is literally struggling at the faults A B C D E F to get through to Z, so that the period of rest for the action of the instrument is the period of greatest activity in the attack on the exposed portions of the wire of the faults in the insulation.

Notwithstanding this palpable divergence at the very threshold of the exploration, it is often assumed that the experience and the dicta of a public telegraph engineer are fitly applicable to questions appertaining to phenomena met with only in the use of electric bell plant. Let us not be misunderstood here; we have not the slightest wish to underrate the qualifications of the public telegraph engineer; we only insist that there are several essentials to success in electric bell fitting that do not come within the experience of the telegraph engineer *(par excellance)*, and in view of the coming marriage of telephony to telegraphy, it is important to ascertain whether the bonds that are to unite them do not essentially reside in the domain occupied with electric bell plant and operatives. With this modest protest let us examine more closely the *rationale* of our illustration Fig. 2.

In speaking of the dissolution of the positive wire at the faults indicated in the diagram we need not enter fully into the details of the process, as any good work on electro-metallurgy will fully explain them, but there are peculiar phases that require careful analysis before true data can be collected for the calculation that is frequently required before a practical degree of permanency can be forecast.

The fault at A shall represent a fault arising from the pressure of a staple on the positive and negative wire otherwise the main and return wire or the main and line wire. The insulating material being ruptured the bare wires are exposed to the action of damp, and when it is remembered that any fissure or crack of microscopic minutes in a damp atmosphere becomes full of water, and this water touches a body of metal, it will be seen at once that between the ruptured covering of the two wires, the water will form a conducting medium for the current from positive wire through water to staple thence from staple through water to positive wire.

This action will produce the treefold effect—viz., to rob the bell or other instrument of part of the current designed to actuate it; to partially dissolve the positive wire at that point; and to throw so much abnormal wear and tear upon the battery. The faults at B shall represent a number of infinitely minute flaws, or pores, in a poor nonconducting covering, each so minute that the dissolution of the positive wire, when enveloped in damp or water, is so slight as to be practically inapplicable as regards the ultimate rupture of the wire; but in the aggregate will contribute seriously to the early exhaustion of the battery, and to the diversion of the electro-motive force before it reaches the bell or instrument. The faults at C shall represent such imperfections in the insulation as occur in a damp place where the wires rest against metal pipes, or other metal surface, and the thick dotted line shall stand for a flaw in each wire coming very near the metal. The fault at D, *d*, shall represent the wires, having a good average covering, but being in a wet or damp place, the current, escaping at D, travels back through the wet, or through meeting another conductor along its course until it finds a flow in the negative wire. The fault at E shall represent a single fault in the positive wire adjoining a portion of the negative wire with many faults.

It will be observed that these faults are representations of many others that may be multiplied by tens, hundreds, or thousands in the same plant.

We must now refer again to them *seriatim* to find a more complete basis for calculation than we have at present in review

(TO BE CONTINUED).

THE ELECTRIC CONDUCTIVITY OF CARBON UNDER DIFFERENT PRESSURES.

As early as the year 1856 M. du Moncel found that the electric resistance of certain moderately conductive powders, especially graphite, changes under pressure, decreasing when the pressure increases, and increasing when the pressure decreases. In the year 1865 M. Clérac constructed rheostats of graphite based on this property, which consisted of tubes containing graphite powder, on which a pressure could be exercised within certain limits. This discovery was, however, neglected until recently, when the discovery of Edison's telephone, Hughes's microphone, Edison's rheostat and microtasimeter, and other instruments gave a higher importance to this property of carbon to alter in resistance under pressure. The circumstance, especially that graphite buttons have been introduced into the construction of instruments for scientific researches, has necessitated a research into this phenomenon, especially directed to ascertain whether this property appears in every sort of carbon, although in different ways, or only in certain qualities; whether there exists a general law which connects the resistance with the pressure, or whether each kind of carbon behaves in a special way;

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whether there is to be found a relation between the specific resistance and the density of the carbon, and whether the continuity and discontinuity of the substance exercises an influence on the phenomenon. Such a research has been made by Mr. R. Ferrini, and the results are as follow:—The method of the research for this purpose is simple and prescribed by the nature of the problem. It consists in the measurement of the resistance of the individually examined pieces by means of a differential galvanometer, whilst the pressures, in a certain order, are increased or decreased.

A battery of four Leclanché elements served as a source of current from which one pole was joined to the apparatus which contained the carbon to be pressed, and the other to a known resistance which could be altered at pleasure, and the difference between the two resistances was measured by an Ebelmann's needle. By means of a Foucault commutator the direction of the current could be altered as often as wished, and polarisation excluded from the observation. The carbon used was in pieces of cylindrical or prismatical shape in a single lump, or consisting of parts of 3 cm. height, which were compressed between a suitable contrivance with a micrometer screw. Eight different sorts of carbon were experimented with, and in this way at increasing and decreasing pressures, which varied between 1 and 11 mm. on the scale. Out of the numeric results found Mr. Ferrini draws the following conclusions:—

1. All the examined carbons both coherent and in grains, gain in conductivity with increasing pressure, and lose on conductivity with decreasing pressure.

2. In general, denser carbons are better conductors, but there are very great differences between two carbons of almost the same density, which probably depend on their composition.

3. The more compact and harder carbons are in general less sensitive to the changes of pressure. Whilst, for example, for tubular forms of carbon and for Carré's carbon the decrease of resistance caused by the increase of pressure from 1 to 9 mm. varies between 0·5 and 0·7 of the original resistance, on the other hand the analogous decrease for three other sorts of carbon, which were higher in resistance at first, is only $\frac{1}{11}$ of the original value.

4. The change which is produced in the specific conductivity of carbon by change of pressure seems to be representable generally by the sum of two expressions, one of which represents the chief effect, which is a momentary one and disappears with the restoration of the pressure to its previous value; the other points to a secondary effect, which is of more or less duration according to circumstances, and sometimes still exists after the original pressure is restored.

At the end of a series of experiments in which carbon, in one or more pieces or in powder, was subjected to a gradually increasing pressure, and left for several hours under the last pressure, the resistance was found almost always diminished. The contrary happened when the pressure was gradually lessened, and the carbon left finally for a long time under a very slight pressure. On comparing further the resistances which were measured in two successive series of experiments, one of which was executed with gradually increasing or decreasing pressures, and the other with the reverse pressure, it was found that the resistances due to decreasing pressures were always lower than those of the other series, with the exception of the smallest pressures. The differences between both the series of resistances were generally remarkable, and relatively higher the higher the sensibility of the carbon examined.

5. The relative value of the secondary effect gains in importance with the increase of pressure. If, then, this pressure does not overstep the limit by means of which it is possible to keep it proportional to the shifting of the screw, tolerably consistent results are obtained. If, however, this limit is trespassed, the carbon acquires a permanent decrease of resistance. In other experiments the resistance of a block of Carré's carbon answering to the pressure of 1mm. was reduced in this way from 0·92 Siemens' units to 0·67 Siemens' units. The permanently modified piece does not, however, cease to alter in proportion to the pressure, like the others. It has lost little or nothing of its sensibility and shows perhaps a still more regular pace in its gradations of conductivity. For this reason the carbon has been exposed in most of the later experiments to a longer pressure before the actual test of it was made.

6. Since a change of pressure produces an immediate effect, which is followed by another less significant, which terminates slowly, it is clear, therefore, that the falls of resistance observed under a series of increasing pressures at short intervals, will be all lower than the definitive ones which the same pressures would cause; and that similarly the rises of resistance which are observed in a series of decreasing pressures will be also lower than the definitive ones, which correspond to the same pressures.

As the differences between these definitive resistances and those resulting from the experiments have contrary signs, and probably do not much differ from each other, Mr. Ferrini, therefore, took the arithmetic mean of the values of the rising and falling series as the probable expression of the definitive resistance for the corresponding pressure, and examined whether the law of the decrease of the resistance is the same with the pressure for the various carbons by the graphic method. The curves obtained formed branches of an equilateral hyperbole. Calculation by the method of least squares led also to the same result, namely, that for every carbon the difference between its real resistance and the limit, towards which it inclines at infinite increase of pressure, is in inverse ratio to the corresponding pressure, counted from a special origin different for each experiment. The differences between the calculated values and those given by experiments were small, and Mr. Ferrini therefore comes to the conclusion that the discovered law is a general one, and valid for all sorts of carbon, as well for single cylindrical pieces as for piles consisting of smaller parts.

Graphite powder does not seem to submit to the established law, much more, it gives different values from one experiment to another. Mr. Ferrini finds that for various sorts of carbon, although in general the denser sorts are better conductors, yet the variations in their composition or manufacture have a more decided influence on their resistance. Moreover, independently of the secondary effect of pressure, there were changes observed in the resistance of the carbons whose origin is very difficult to explain. Although according to the foregoing researches the various carbons obey a mutual law in the change of their specific conductivity with pressure, it is not advisable to employ carbon as a scientific meter, by which the resistance can be calculated from the pressure.—Abridged from *Der Naturforscher*.

CONTRIBUTIONS TO A PHYSICAL THEORY OF ELECTRICITY.

BY DESMOND G. FITZGERALD.

(CONTINUED FROM PAGE 21.)

The absence of logical method and precision in the statements and allegations which from time to time have been brought forward in support of the very prevalent impression or feeling that "electricity" may or must be a "force" or mode of energy, and the "atmosphere of bias"—due to the fact that heat and light, formerly classed with electricity as "imponderables," have been shown to be modes of motion—which surrounds the question as to the nature of "electricity," have rendered it almost unaccountably difficult to combat this impression by any concise appeal to admitted experimental fact. The very vagueness of the impression, the indefiniteness of its presumed foundations, the assumption that it may be allowed to take the place of an old theory without any attempt being made to refute the latter, contribute to render it elusive and almost unattackable by argument. Unless we have a rigid set of definitions, and unless indeed we adopt the plan of substituting mathematical expressions for terms which by any possibility can be misconstrued, it is weary work to lead a disciple of the "advanced" ideas from the statement that "electricity is a force" to the successive admissions:—1. That the voltameter and galvanometer, or the *electricity-measurers*, measure something different and entirely distinct from *force*; 2. That what he meant by "a force" was in reality a "mode of energy;" 3. That the voltameter and galvanometer measure something which is different and distinct from energy; 4. That what he calls "electricity" is something perfectly well known under the term *electrical energy*; 5. That the term "electricity" properly belongs, not to the latter value, but to its quotient by another value with which he is familiar, *i.e.*, to that quantity which is measured by the voltameter and galvanometer; and, 5, that this quantity, indicated by electricity-measurers, is independent either of force or energy, constant under conditions in which these may be varied at will, and that it cannot possibly represent, or be converted into, heat or any other mode of energy. But it is in many cases only after this work has been done that we can arrive at the logical form of the proposition which in reality underlies the views which have sometimes been erroneously dignified by the title of "The Dynamic Theory of Electricity," viz., the form which directly denies the objective existence of anything corresponding to that which is apparently measured by the voltameter or galvanometer, and which is expressed by the formula $\frac{E}{R}\theta$ or $\frac{T}{R^i}$.*

* Here E stands for "*electromotive force*," R for *conductive resistance*, θ for time, T for *tension* or *potential*, and R^i for *inductive resistance*, or the reciprocal of inductive capacity.

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From these strictures of indefiniteness and want of precision I must, however, exempt at least one authority, viz., Prof. W. F. Barrett. After pointing out that the "electric force" invested in a conductor may be as truly and directly converted into heat as the "motive force" invested in a cannon-ball—a statement to which I think no objection could be taken if the word "energy" were substituted for "force,"—Prof. Barrett says:—

"Let the energy of an electric current passing through a good conductor be measured in the usual way, either by the amount of water it will decompose in a given time or by the deflection of a magnetic needle; for the perfect substitute an imperfect conductor. The amount of electricity passing through the circuit will now be less, *the missing quantity having been converted into heat;* for in the former case the conductor remains cold, while in the latter it is heated."*

Here, certainly, the statements made have no uncertain sound, nor are they open in any degree to the objection of vagueness. We are told in the first place that the energy of a current may be measured by means of a voltameter or a galvanometer. These being precisely the means by which it is claimed that *electricity* is measured, and by which the ratio $\frac{E}{R}$ is certainly measured; it follows, according to this authority, that electricity and electrical energy must be identical, and that they are both expressed by this ratio. Unfortunately for this view, however, it has been shown by Joule, and it can be readily demonstrated, that electrical energy is in all cases measured by the ratio $\frac{E^2}{R}$. Next we are given to understand that, when a current of electricity traversing a circuit is diminished by the insertion of an additional resistance, the missing quantity (or $\frac{E\,r}{R^2 + R\,r}$, if r be the additional resistance) is converted into heat. Unfortunately, again, for this ingenious exposition—according to which the heat evolved must necessarily be greater in an open than in a closed voltaic circuit—it follows from Faraday's law of the proportionality between current and zinc consumed in each cell, and it can readily be demonstrated, that the zinc corresponding to the "missing quantity" is *not consumed* when the imperfect conductor is substituted for the "perfect" one. We have therefore in this case, if we are to accept the exposition in question, a direct creation of energy; and, as not unfrequently happens, our author, in seeking to overturn the "fluid" theory of electricity, runs full tilt against the principle of the conservation of energy. It is scarcely necessary to point out that this authority is obviously unaware of the facts that the total heat $\left(\frac{E^2}{R}\right)$ evolved in the circuit before the additional resistance is introduced is *greater* (by the quantity $\frac{E^2\,r}{R^2 + R\,r}$) than that $\left(\frac{E^2}{R + r}\right)$ evolved after the insertion of the imperfect conductor, and that the *diminution* of heat produced by this means is necessarily proportionate to the diminution of current. It would appear that the production of a high *temperature* in a resistance, such as a thin platinum wire, inserted in a voltaic circuit has very frequently been assumed as evidence that the *heat* generated in the circuit is increased by the insertion of the resistance; and this fallacy has led to the greater blunder of supposing that the missing "electricity" may have been converted into heat.

In regard to one of the propositions which I have undertaken to maintain, I think it has been shown that there are in reality three views prevalent as to the nature of "electricity," of which two only are actually in antagonism; since the remaining one is logically so weak, and so obviously founded upon a misapprehension of facts, that any refutation of it is necessary only as a matter of form, or in order to safeguard the electrical student against an erroneous impression. These views are:—

1. There is a something, (expressed by the ratio $\frac{E}{R}$) which may be termed "electricity:" it is material or analogous to matter, and may be represented to the mind by the expression "imponderable fluid."

2. There is a something (expressed by the ratio $\frac{E}{R}$) that may be termed "electricity;" but it is not material or in any sense analogous to matter. It is a mode of motion or form of energy; and may be converted into heat or work.

3. There is nothing, of a substantive or physical nature, corresponding to the idea of "electricity" or to the mathematical value $\frac{E}{R}$. There is an electrical energy, necessarily equivalent to $\frac{E^2}{R}$, which is the true cause of electrical phenomena, and which may become converted into heat or work.

The following considerations, even when taken apart from the logical and mathematical objection which has been stated, may (if they be not regarded as superfluous) be considered sufficient to dispose, *in limine*, of the second of these views. I put them forward mainly in order to aid the elementary student in arriving at a conclusion.

(*a.*) The value of $\frac{E}{R}$, or the quantity of electricity passing in a conductive circuit, is, subsequently to the minute period of "variable condition" which precedes the normal distribution of the static charge, the same in every portion of the circuit taken as a whole. But, if the heat evolved or work done during the passage of electricity through a conductor resulted from the conversion of electricity, we should necessarily have different values of $\frac{E}{R}$ in different portions of the circuit; since it would be impossible to cause electricity to traverse a resistance without converting some portion of it into heat or work.

(*b.*) Further, since we know that if a given length of submarine cable (or a given condenser) charged to a given electrostatic tension or potential be connected with a second similar length of cable (or condenser), the potential will be exactly halved, the fundamental electrostatic law $T = Q\,R^i = \frac{Q}{C}$, (T being *tension* or *potential*, Q *quantity*, R^i *inductive resistance*, and C the reciprocal of the latter or *inductive capacity*) must, if there be any conversion of the electricity passing through the wire resistances, be erroneous. Also, the expressions $Q = \frac{T}{R^i}$, and $R^i = \frac{T}{Q}$, which, with the above equation, constitute the basis of electrostatics, must, in this case, be erroneous.

Further, the heat generated by the conversion of electricity should, other things being equal, be simply proportionate to the quantity of electricity in action. But according to the law of Joule, and to every experimental result, the heat evolved is proportionate to the *square* of the quantity of electricity passing in a given time through a given resistance. So that, as we cannot admit that the effect varies as the square of the cause, if the principle of the convertibility of electricity into heat be true, Joule's law and every experimental result in confirmation of it must be wrong.

Further, if the heat evolved in a circuit of given conductive resistance results from the conversion of electricity, and is proportionate to the quantity of electricity passing in a given time, this heat cannot be proportionate to the quantity of zinc consumed in the battery (which, in the absence of local action, is, with a given resistance, precisely as the square of the current). But, according to the principle of the conservation of energy, the heat due to the oxidation of a given quantity of zinc in the battery, and not rendered sensible at the spot where the chemical action takes place, must be evolved at other portions of the circuit, or become converted into work.

Further, if electricity be convertible into heat and work, it must have a thermal and mechanical equivalent. But no such equivalent has ever been given, and it is simply impossible that it should be given; for, as is shown by the law of Joule $\left(W = I^2\,R\,\theta = E\,I\,\theta = \frac{E^2}{R}\,\theta\right)$ the same quantity, $\left(\frac{E}{R}\,\theta = I\,\theta\right)$, of electricity—even if passing through conductors of equal resistance, *but not in the same time*—may in one case scorch and rend a tree with the terrific energy of the lightning flash, or fuse a solid bar of iron, and in another case be capable only of very slightly raising the temperature of a gramme of water. Thus, for example, let $I\,\theta = 10{,}000$, and $R = 100$. In one case let $\theta = 1$ and $I = 10{,}000$: we shall have $I^2\,R\,\theta = 10{,}000$ millions. In the other case let $\theta = 10{,}000$ and $I = 1$: we shall then have $I^2\,R\,\theta = 1$ million only.

(TO BE CONTINUED.)

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* *Engineering*. Nov. 23, 1866.

THE SOCIETY OF TELEGRAPH ENGINEERS.—The annual general meeting will be held on Wednesday, December 10, 1879, at the Institution of Civil Engineers, for the reception of the annual report of the Council, and for the election of Council and officers for the ensuing year, the ballot for which will be open until 8:30 p.m. A Paper will be read, "On the Operations connected with the Laying of the New Marseilles-Algiers Cable," by E. March Webb, Associate.

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THE ROYAL SOCIETY.

On Monday, Dec. 1st, the President of the Royal Society (W. Spottiswoode, D.C.L., LL.D.), delivered his annual address at the anniversary meeting of the society. He said that in the spring it was customary to elect the annual complement of new Fellows, while in the autumn the names were recounted of those who had dropped from the list. Among members lost by death to the society he mentioned Professor Clerk Maxwell:—"Our last loss" he said, "that of Professor Clerk Maxwell has been in some respects the greatest. In him the full maturity of a mind which had suffered no check or shadow of abatement was devoted to the foundation of a more thorough knowledge of molecular physics and of electrical laws than has hitherto been attained. The clear insight, the keen criticism, the just and liberal appreciation of the views of others, evinced both elsewhere, and especially in his reports to the committee of papers, will long be remembered, while the more genial side of his character, exemplified in the numerous scintillations struck off with his pen, will be no less cherished by those to whom his scientific writings were as a sealed book. To replace such a man seems at first impossible; but we should be doing scant justice to his memory if we did not believe that the good seed which he so liberally sowed would bear such fruit that in the time of need there should be no lack." The details of the ways and means of conducting the society were then described, reference was then made to the papers contributed to the society, and a hope expressed that the method of printing the abstracts in time for the meeting would conduce to the better discussion of the subjects brought forward. A suggestion was made that the hour of meeting should be altered to 5 p.m., and that in order that the friendly talk in the tea room should not be lost, tea should be prepared an hour before the meeting on Thursdays. In speaking more in detail of the papers presented, a well-deserved eulogium was given to Mr. Crookes for his persevering experimental researches upon radiant matter. Another communication, full of promise as well of performance, was that of Professor Hughes on his induction currents balance, the application of which has already branched out and borne fruit in more than one direction. The extreme simplicity of the instruments, and their marvellous adaptation to the purposes for which they were intended, reflect the highest credit on their inventor. The results of recent scientific work of various kinds was described, and it was shown that the needs of science have given rise to the establishment of special institutes and societies, where many subjects first brought before the Royal Society are further discussed. Examples were given of Hughes's papers to the Society of Telegraph Engineers, of Mr. Cowper's electric writing apparatus, of the successes of Mr. Stearn and Mr. Muirhead in duplexing cables, of the progress of the electric light, of telephonic systems, and of the transmission of mechanical power by electric currents. Mention was made of the recent Telegraph Conference. "When telegraphy began to assume an international character, great inconvenience arose from want of uniformity in the apparatus used, and in the service regulations adopted by different European countries. Although the construction of the line (whether submarine, underground, or suspended) and the details of construction of the telegraphic apparatus employed may fairly be left in the hands of each country or telegraphic administration, it was soon found to be necessary that a certain standard of efficiency should be insisted upon. Agreement was, moreover, requisite in regard to the general character of the instruments to be used in international telegraphy; for instance, whether or not acoustic signals were to be admissible, whether an indelible record should be insisted upon, whether a type-printer, or an autographic instrument should be used, or a recording instrument representing the letters by dots and dashes, in which case a uniform code would be a matter of necessity. Beside these points, there remained the subject of the tariff to be charged in each country for transit and for terminal messages, involving delicate questions, which could be settled only by mutual concessions and general arrangements. These considerations led the French Government in 1866 to invite those European Governments who had already taken the administration of the telegraphs in their own hands, to meet at Paris, in order to agree if possible on certain resolutions, subject to ratification by the respective Governments. England was not represented at this first Conference, because the telegraphs were not yet a Government Department, and it was not thought advisable to invite telegraph companies to take part in the proceedings. The result of the first deliberations went beyond the mere settlement of pressing questions, and it was decided to hold periodical Conferences at the different capitals of Europe, and to institute a central International "Bureau" (to be located at Berne) to see to the proper application of the resolutions of the Conferences, and to act as an International Court of Appeal regarding questions of difference in telegraphic matters arising between the contracting countries. The second Conference took place at Vienna in 1869, in which several countries, including Turkey, Persia, and British India, took part for the first time. On this occasion it was resolved that the leading telegraph companies should be admitted to the discussions, but should not be allowed to vote; the power of voting being confined to the Governments, and each country having one vote only, irrespective of its size and importance. The third Conference was held at Rome in December, 1871, when the British Government (Post Office) was for the first time represented, and also the Indo-European and Cable Companies, which latter are bound by the resolutions of the Conference only in matters of international administration, and of tariff in cases where lines join two countries belonging to the Union. The fourth Conference met at St. Petersburg in 1876, and the fifth at London in 1879. At the latter meeting difficult questions of tariff arose, which protracted the sittings over nearly two months. At previous Conferences it had already been decided to treat each country as a unit, its particular charge being the same, whether a message had only to cross the frontier, or had to pass over long distances into the interior. At the London Conference it was proposed by Germany to adopt a uniform rate per international message for the whole of Europe, analogous to the uniform postal rate for letters, while France went further and urged the adoption of a universal *rate per word*. Neither of these measures, however, was adopted, but a compromise was effected; and after the 1st April, 1880, each word will be charged at a specified rate for each country, five words being added to each message to cover time spent in advising, commencing, and finishing it. The next Conference will meet at Berlin in 1884. All European countries, as well as Brazil, Persia, India, and Japan, belong to the Conference, and are bound by its decisions. Any of twelve modern languages using the Roman character may be employed; Russian, Greek, Turkish, being thus excluded from use. It would be difficult to over-estimate the beneficial results produced by these Conferences in stimulating and perfecting international communication. Material is not wanting to extend these notices of scientific activity over a wider range; for our foreign neighbours are always ready to furnish us with information of whatever is new among them either in matter or in method. But a mere enumeration of these things, however interesting in themselves, would form but a dull chapter, unless it should issue in a judicial estimate of results, or a suggestive comparison of national arrangements for the promotion of science. On such an enterprise I am by no means prepared to adventure myself; and even if I should be ever led to make the attempt on some special topic, or some particular aspect of the question, I must, at all events, defer it to a future occasion."

FORMULÆ FOR ELECTRICAL WORK.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you kindly help me out of a difficulty? In Professor Jenkin's "Electricity and Magnetism," page 108, I read:—"We know by the definition of potential that the work so done in conveying the quantity q of electricity between two points at potentials differing by the amount i is equal to $q\,i$, or $i = \frac{w}{q}$."

In *The Electrician*, vol. 11, p. 261, Mr. FitzGerald says:—"Generally, if T be the tension (or potential) of a charge, Q its quantity, and W the work done when the charge flows to earth, we have $T = \frac{2\,W}{Q}$."

I cannot understand how the potential can $= \frac{w}{q}$ and at the same time $= \frac{2\,W}{Q}$, if w and W = work, and q and Q = quantity.

—Yours, &c., J. W. W.

Oxford, Nov. 28.

[The former of the two equations is abstract, the latter concrete—that is to say *arithmetically* correct if certain specified units (the B.A. units) are used. Strictly speaking, the sign of variation ($\propto$) should be used, instead of that of equality, in abstract equations; *e.g.* $R \propto \frac{l}{d^2}$, instead of $R = \frac{l}{d^2}$; the latter expression requiring a numerical constant to render it *arithmetically* correct.—ED. *E.*]

M. C. Clamond's communication, in relation to Edison's "Electro-Generator," is again, unfortunately, crowded out.

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TELEGRAPH SHARE LIST.

Companies.	Closing Prices Dec. 3.		Business Done Week Ending Dec. 3. Highest.	Lowest.
Anglo-American Ordinary	55½,	6	55⅝	54¼
Do. "B"	81¼,	⅝	81⅛	81
Do. "A"	31,	⅛	31⅜	30⅛
Brazilian	7 7-16	9-16	7 9-16	7⅛
Cuba	8¼,	¾	8⅛	⅝
Do. Ten per Cent. Preference	15,	16	—	—
Direct Spanish	2¼,	⅛	—	—
Do. Ten per Cent. Preference	11⅜,	12⅛	11⅜	11⅛
Direct United States	10⅛,	⅛	10⅛	10⅛
Eastern	8⅝,	¾	8¾	8⅜
Do. Six per Cent. Debenture	102,	5	—	—
Do. Five per Cent. do	101,	4	103	101½
Do. Six per Cent. Preference	11⅞,	12	12	12
Eastern Extension	8 9-16,	11-16	8 11-16	8½
Do. Six per Cent. Deb.	106,	9	108⅛	106½
German Union	7⅞,	8	—	—
Globe Telegraph and Trust	4 15-16,	5 1-16	5 1-16	4 15-16
Do. Six per Cent. Preference	11 1-16,	3-16	11¼	11
Great Northern	8⅛,	¾	8⅞	8 11-16
Indo-European	22½,	3⅛	—	—
Mediterranean Extension	2⅛,	3	3	2¾
Do. Eight per Cent. Preference	9¾,	10½	10⅛	9⅝
Reuter's	10,	11	10⅛	10
Submarine	230,	40	—	—
West India and Panama	1⅞,	⅝	1⅝	1 7-16
Do. Six per Cent. Preference	7⅜,	⅝	7 9-16	7⅜
Western and Brazilian	5⅛,	⅝	5⅞	4 9-16
West. Union Seven per Ct. 1st Mt.	120,	25	—	—
Do. Six per Cent. Sterling	105,	7	—	—

TRAFFIC RECEIPTS FOR NOVEMBER, 1879.

Companies.	Nov. 1879.	Nov. 1878.	Incrse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	3,000 estd.	2,609	491	—
Direct Spanish Telegraph Company	1,334	1,002	332	—
Direct United States Telegraph Company	—	—	—	—
Eastern Telegraph Company	46,147	37,170	8,977	—
Eastern Extension Telegraph Company	26,379	25,280	1,099	—
Great Northern Telegraph Company	16,653	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—

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TABLE OF THE TOTAL ADDITIONS MADE UP TO DECEMBER 31, 1874, TO POLICIES OF £1,000 EACH.

Ages at Entry.	Number of Premiums Paid. Thirty.	Twenty-five	Twenty.	Fifteen.	Ten.	Five.
30	£685 10 0	£549 0 0	£434 10 0	£290 10 0	£175 0 0	£78 10 0
45	841 0 0	678 10 0	533 0 0	353 10 0	211 0 0	93 0 0
60	——	——	787 10 0	517 0 0	310 10 0	137 10 0

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India Rubber.—The British Consul at Panama reports that rubber has almost ceased to be an export from the Isthmus.

Lady Sabine.—The wife of Sir Edward Sabine, so well known for his researches in terrestrial magnetism, died on the 28th ult. at Ashley-place. She was a remarkable woman, and largely aided her husband in his investigations.

Shoreditch.—Messrs. Wells and Co., the firm to whom we owe the introduction of the Jablochkoff light, are seriously thinking of entirely doing away with gas and depending solely on the electric light to illumine their extensive works.

The Electric Light on Indian Railways.—The electric light is being used on the Northern Punjaub State Railway, which is being pushed on very rapidly. We shall be glad to hear if Mr. Schwendler's ideas as given in his *précis* are corroborated in practice.

Electro and Nickel Plate.—The Plating Company of Stockton-on-Tees has taken some large Government contracts for marine engine and ship fittings. The trade in this direction is greatly developing, and we have no doubt competition will still further increase it.

Clark's Standard Element.—M. Pellat finds that this cell is subject to slight variations in electromotive force, one cell differing from another by a quantity equal to $\frac{1}{100}$ of the electromotive force of a Daniel element. M. Pellat used an electrometer in his measurements.

The Electric Light in Paris.—It is intended to carry out a comparative trial, at the Opera and at one of the halls of the St. Lazare Station, between the Jablochkoff candle and the Werderman lamp, and also between the Jablochkoff candle and the lamps of Lontin and of Siemens.

Torpedo Boats and the Electric Light.—From the recent torpedo experiments made on board the Bloodhound with the electric light it would appear that black painted boats are least distinguishable by the electric light, while white, red, and green, were the next in order of plainness.

The Cape Cable.—The Scotia and the Kangaroo, belonging to the Telegraph Construction and Maintenance Company, commenced laying the last section (Aden-Zanzibar) Cape cable on Wednesday, Dec. 10. The Seine, with the Australian duplicate cable, arrived at Aden on Monday, Dec. 8.

The Electric Light in Woolwich.—Messrs. Siemens are lighting, by means of three of their 6,000 candle machines, the shops of some enterprising Woolwich tradesmen. The steam power required for driving the machines is obtained from the waterside works of Messrs. Rose and Mellish. The light will burn for the first time from dusk till midnight to-day.

Decorations for Gallantry.—The Portuguese Government have decorated Messrs. E. V. Wyse, H. G. Cheesman and William Cross, of the Eastern Telegraph Company's station at Carcavellos, near Lisbon, with the Portuguese Order of Merit, for saving the life of a sailor from the wreck of the Maria Christina steamer, stranded at the mouth of the Tagus, near the Eastern Company's station.

School of Telegraphy.—We are informed that, in addition to the usual course of study, a new subject has been established in the work at the School of Telegraphy. Students can in future join classes in which a complete theoretical and practical course of instruction in telephony and electric lighting will be given, to enable men to qualify as inspectors and engineers in these branches of applied electricity.

Preparing Steel.—A novel mode of preparing steel has been suggested by Signor Guido, an Italian engineer. It consists in electrolysing water by means of a dynamo-machine, and smelting the carboniferous ore by reducing it with the oxygen and hydrogen gas obtained, and thus producing either steel or pure malleable iron at will. To turn out two tons daily would, however, require the constant use of a 120 horse-power engine.

A Simple Method of Classing Steel.—Herr Barus has proposed a method of classing steel, in a memoir discussing the thermo-electric properties and electrical conductivity of steels in relation to their hardening qualities. He divides steel into two classes. One class, which comprises the harder varieties, he finds to be electro-negative to copper; and the other, comprehending the softer varieties, electro-positive.

Mr. Gladstone and the Telephone.—When the ex-Premier addressed the monster audience in the Corn Exchange, Edinburgh, a telephone was planted on the desk to convey his oration to a number of people collected in a neighbouring hall; but only a small part of the speech could be heard, for the modern Cicero, according to an established habit of his, placed his hat right in front of him, and screened off the sound of his voice from the diaphragm of the telephone.

The Late Professor Clerk Maxwell.—A general feeling having been expressed that the University of Cambridge should possess some memorial in honour of this, one of her most celebrated sons, an effort is to be made to carry out the suggestion. We may venture to remark that a scholarship founded in the name of the late professor, and connected with the Cavendish Laboratory, would perpetuate the memory—and show the esteem in which he was held—of one who spent his best energies in perfecting the design of the laboratory.

Marat and Robespierre.—We are indebted to Mr. A. J. Frost, the energetic compiler of the Ronalds library catalogue, for the following curious and interesting notes:—"It is perhaps not generally known that Jean Paul Marat, one of the most prominent characters of the first French Revolution, and who was assassinated by Charlotte Corday, wrote several important works upon electricity, most of which were translated in German. These works were written and published between 1779 and 1785." Robespierre also contributed a paper to the *Journ. des Savants* on "Paratonnerre."

Another Company. — The Electric Carbon Company (Limited), with a capital of £15,000, in shares of £5, is formed to acquire certain patents granted to F. J. de Hamel for making carbons of various descriptions, the manufacture and sale of electric carbon, plates, cylinders, and other appurtenances for electrical purposes. The subscribers are:—F. H. de Hamel, 70, Avenue-road, 50; A. D. de Hamel, Tamworth, 50; S. Foster, 27, James-street, 50; G. Smith, West Dulwich, 50; H. S. Foster, 3, Copthall-buildings, 1; C. Hight, 3, Copthall-buildings, 1; F. Howard, Peckham-rye, 1.

The Pantelephone is a speaking microphone, devised by M. de Locht-Labye, which the inventor expects to prove superior to all other systems. It consists essentially of a very light metal plate of aluminium suspended vertically by two delicate springs from a rigid piece, supported by a bracket from the wall. To the lower part of the plate is fixed a

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carbon contact on which leans a short steel spring with a pressure adjustable by a screw. The apparatus is interposed in a voltaic circuit minus an induction coil. So sensitive is it that it will transmit speech though placed 15 metres from the speaker. It seems, indeed, to resemble very closely the well-known Blake transmitter.

THE MICRO-TELEPHONE.—Mr. Hunnings, in a letter to the *Daily News*, says:—"On Tuesday, November 18th, I was invited by the Leeds Philosophioal Society to exhibit my 'micro-telephone' at their *conversazione*. They procured the use of a private line wire kindly lent by the Aireside Hematite Iron Company. The wire is rented from the post-office authorities, and runs some considerable distance underground in a cable of eighty wires, thereby giving a very considerable amount of induction; in addition to this, my telephone line wire ran side by side into the Philosophical Hall with the cable from a dynamo-machine for the electric light. Notwithstanding all this, a conversation in a loud tone was kept up for over two hours without the slightest difficulty or interruption from induction. The line was about three miles long."

THE ELECTRIC LIGHT.—The introduction of the electric light in single instances is still quietly going on both at home and abroad. The Inman Company being desirous of testing its adaptability on board ocean-going vessels have resolved to fit them up on trial all over the passenger deck of their steamer, the City of Berlin. It has also been adapted to the Quai de la Bourse, Rouen, to facilitate the unloading of ships by night. The Gare d'Anvers, Paris, a space 700 metres long by 200 broad, has been lit by thirty-two Jablochkoff candles, fed by two pairs of Gramme machines actuated by two steam engines of 20 horse-power. A new company has been started in Paris, with a capital of £80,000, purporting to furnish electric lights from Bunsen cells of special make, without the need either of regulators or dynamo-machines.

THE FRENCH ATLANTIC CABLE.—M. George Van Chauvin is at Ottawa on behalf of the new French Cable Company, with a view to ascertaining what steps are necessary in order to effect a landing on Canadian territory. The Dominion law provides that any British company shall have the right to land cables upon taking out letters patent for that purpose. This appears to preclude the French company; but should it be so interpreted by the Ottawa authorities, no obstacle is likely to be put in the way of conceding the privilege by fresh legislation. As soon as the application for power to effect a landing in Canada is granted, the company propose to lay a cable from the island of St. Pierre de Miquelon (which is the only vestige that remains of French domination in North America) to a point either on Cape Breton or the Nova Scotia mainland, near the Gut of Canso, and thence to connect with the telegraph systems of the Dominion. M. Van Chauvin is accompanied by Baron de Cambray.—*Times*.

HOW FAR CAN WE HEAR WITH THE TELEPHONE?—This is a question frequently asked, but we believe has not yet been definitely settled. The longest distance that we have seen mentioned is given in the item below, namely, two thousand miles. But perhaps Mr. Edison has had more extended experiences. If so we should be glad if he would let our readers know. An exchange states that Mr. Robert A. Packer, superintendent of the Pennsylvania Railroad, is at present hunting with a party of gentlemen in Nebraska. A few days ago he for two hours conversed pleasantly with his wife and friends at Sayre, Pa., his brother at Mauch Chunk, Pa., and friends along the line. The medium was the railroad and Western Union Telegraph wires and Edison's telephone. At the office in Bethlehem, Pa., connection was made with the Easton and Amboy wire, and at Perth Amboy with a Western Union wire, and thence to Chicago and North Bend, Nebraska, where the party are. The distance was about two thousand miles, and every whisper was audible.

COATING IRON WITH A MAGNETIC OXIDE.—In the course of experiments with Bower's process for coating iron with magnetic oxide by a current of hot air, it was found, Mr. G. R. Tweedie says, that the action was due to the combination of atmospheric oxygen with the carbon of the iron to form carbonic anhydride, which was then reduced by the iron according to the well-known equation $4CO_2 + Fe_3 = Fe_3O_4 + 4CO$. Hence this process was found to be unsuitable for coating wrought iron or steel. The mode of procedure now adopted is to heat the articles to be coated in a current of impure carbonic anhydride, obtained by the combustion of small coal. By this means a coating of magnetic oxide is obtained slightly contaminated with red oxide, the conversion of which into magnetic oxide is then effected by adjusting the air supply of the furnace, so as to substitute a current of carbonic oxide for the carbonic anhydride, $3Fe_2O_3 + CO = 2Fe_3O_4 + CO_2$. The coating thus produced is very hard, homogenous, and withstands ordinary oxidising influences.

AN ELECTRO-OPTIC REGULATOR.—In recent experiments of Mr. Albert A. Michelson, of the U.S. Navy, to determine the velocity of light by means of a revolving mirror, a novel device was employed to measure and regulate the speed of rotation. This consisted of a tuning fork, bearing a steel mirror on one prong, and kept in vibration by a battery of five gravity cells. The fork was so placed that the light from the revolving mirror was reflected to the piece of plane glass in the eye-piece, thence reflected into the eye. When fork and revolving mirror are both at rest the eye sees an image of the revolving mirror. When the fork vibrates this image is drawn out into a band of light. When the mirror commences to revolve this band breaks up into a number of moving images of the mirror; and when, finally, the mirror makes as many turns as the fork makes vibrations these images are reduced to one which is stationary. This is also the case when the number of turns is a sub-multiple. When it is a multiple or a simple ratio the only difference is that there will be more than one image. The fork makes about 128 vibrations per second. No dependence was placed upon this rate, however, but at each set of observations it was compared with a standard Ut_3 fork, the temperature being noted at the same time. In making the comparison the beats were counted for 60 seconds. It is interesting to note that the electric fork, as long as it remained untouched and at the same temperature, did not change its rate more than 0·01 or 0·02 vibrations per second.

THE EXPLOSION ON BOARD THE CABLE STEAMER INVESTIGATOR.—A novel point in mercantile marine insurance law was decided in the Court of Appeal on Monday last. The question in this cause was whether the bursting of a boiler of a steamship was one of the "perils" of navigation covered by a policy of insurance. The plaintiffs were the West India and Panama Telegraph Company and the defendants the Home and Colonial Insurance Company. In order to repair their telegraph cables, when injured, between the West Indies and America, the plaintiff company purchased a steamer, of 569 tons register, in April, 1875. She was then thoroughly overhauled by Board of Trade and

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Lloyds' surveyors. Before proceeding to St. Thomas she was insured. On the 9th May, 1877, on the expiration of the policy, she was reinsured for twelvemonths in the aggregate sum of £20,000. The "perils" insured against were "dangers and perils of the sea, and all other perils, losses or misfortunes" that might happen to the vessel. On the 8th January last the port boiler of the vessel burst as she was getting ready to leave St. Thomas, and the ship, though saved from sinking, was so damaged that her remains were sold for £250. The defendant company refused to pay the policy on the ground that the boiler plates had been worn out in part by fair wear and tear, and their bursting in consequence was not a "peril" insured against. This was a novel point in mercantile marine insurance law.—The Judge held that a boiler was as much a part of the navigating apparatus of a steamer as the sails were of a sailing vessel, and that its bursting was a peril incident to steam navigation, and consequently covered by a policy of insurance. On the evidence he held that the direct cause of the explosion was neglect, and not fair wear and tear. Judgment would be for the plaintiffs. No order was made as to costs, they having been agreed to by the litigants beforehand.

The Theory of the Microphone.—The action of the microphone has been exhaustively studied by Dr. Julian Ochorowicz, and his results have just appeared in the form of three articles to our excellent French contemporary *La Lumière Electrique*. Dr. Ochorowicz finds that the distinctness of articulate microphonic sounds is in inverse ratio to their intensity, that the intensity grows in proportion as the vibrations tend to interrupt the current, whilst, at the same time, the power of sending completely articulate sounds disappears. Hence the difficulty of amplifying sounds at will. The intensity of the sounds is also in direct ratio with the intensity of the current, but this ratio fails also when a certain strength of current is overstepped. Microphonic effects are proved to depend very much on the rapidity of movement of the constituent parts of the microphone; in fact changes of resistance and strength of current are alone not sufficient to produce microphonic phenomena; it is indispensable that these changes should be rapid. The simple sounds which result from a series of complete interruptions have always the same intensity and the same *timbre* independently of the energy which provokes them, but they change in intensity, and are in harmony with the force of the current. When the microphone is employed as a *thermoscope*, the changes in the conducting points of the sensitive contact have no need to be rapid as when a telephonic effect is desired. Another difference, apparently contradictory, has been remarked. "It is well known that the micro-tasimeter of Mr. Edison presents," says Dr. Ochorowicz, "effects quite the opposite of those of the thermoscopic microphone of Professor Hughes. In the former, heat acts by augmentation of conductivity; while, in the latter, heat increases the resistance. For in the first case it is a solid body which dilates under the influence of the heat in augmenting the number of contacts, while, in the second, where there exist several particles of carbon in contact, it is the air encircling and separating them which dilates and thereby *diminishes* the number of contacts; but the principle remains the same." Dr. Ochorowicz concludes that "we cannot attribute the action of the microphone to a new property of matter, or at least to a direct action of sonorous waves on certain moderately conducting bodies. The microphone has no analogy with the microscope, and its theory has no relation with that of *selenium*; but these facts do not forbid the invention of Professor Hughes from being one of the greatest of our century. The other 'pressure' theory is even more untenable."

Hull and the Electric Light.—A special meeting of the members of the Hull Town Council was held at the Town Hall last week, the Mayor (Alderman King, M.D.) in the chair, for the purpose of considering the advisability of, and to sanction the Corporation applying to Parliament for, a Bill enabling them to obtain all necessary powers for lighting the borough and abjoining districts by means of electricity, or otherwise than by means of gas, and also for manufacturing and supplying the electric light and other matters. Mr. Elam, the chairman of the Gas Inquiry Committee, in moving the resolution enabling the Council to obtain the powers alluded to, urged, in favour of his proposition, that he had seen the light working in London and other places with the greatest success. The Metropolitan Board of Works were now producing the light at less cost than gas, and the same may be said of the experiments at the British Museum. At the Picton Gallery, Liverpool, and at Blackpool the light had likewise been used with the greatest success; whilst the reports of high officials of the Liverpool Corporation and the chief engineer of the Mersey Dock and Harbour Board were equally in its favour. All he (the speaker) asked of the Corporation was to get the power and use it to a very limited extent. He deprecated a large expenditure in the matter, and pointed out that the Corporation could do the same as the Metropolitan Board of Works, and contract for a given length. Mr. Hodge seconded the resolution. Mr. Laverack regretted that he should have to move an amendment, but he felt that Mr. Elam or the Gas Inquiry Committee had failed to show that the time had arrived for its adoption in the town. The question of cost was one of the chief points in the matter, but the real contention was whether it was practicable. He contended that it was not, and he moved the following amendment:—"That in the absence of any information as to the cost of street-lighting by electricity the Council deem it undesirable at present to make any application to Parliament for powers to light the borough by means of electricity, and that all resolutions to the contrary be rescinded." Mr. Laverack, continuing, showed that the street lamps in Hull were costing the Corporation ¼d. per hour each, whilst the electric light on the Thames Embankment cost 5½d. per hour each, and in Paris 3d. an hour. He therefore argued that there would be no saving to the town in the adoption of the electric light, and he viewed the expenditure upon such experiments as a scandalous waste of money.—Mr. Larard seconded the amendment.—A long discussion took place, in which Ald. Seaton supported the amendment, on the ground that everything was to be gained by waiting, whilst, on the other hand, there was much to be lost by precipitancy.—The Mayor and the ex-Mayor (Ald. Waller) supported the resolution, the latter stating that whilst in one portion of the town £3 5s. per lamp was charged by the British Gas Company, in the east portion another company charged £4 7s. 2d. per lamp, which he considered was a sufficient inducement for the Corporation to take steps to liberate themselves in the matter.—Mr. Stuart supported the resolution, on the ground that whilst the cost would be small the future benefits to the ratepayers would be incalculable.—Ald. Leak, the chairman of the Property Committee, urged the Council to grasp the opportunity presented, contending that their first duty was to secure measures which would be of lasting benefit to the townspeople.—The amendment was negatived, and on a division being taken on the original motion it was declared by 36 as against 12.

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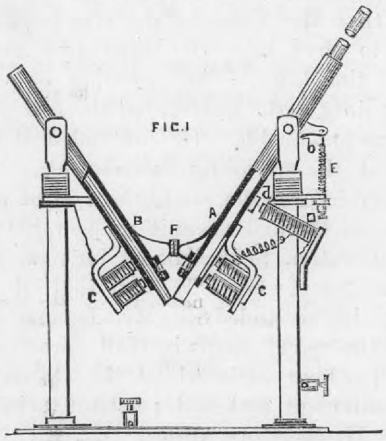
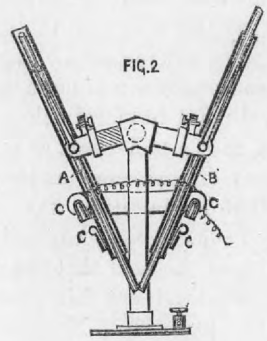
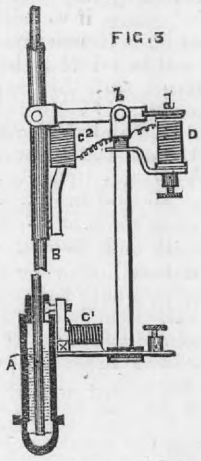
HEDGES' IMPROVEMENTS IN ELECTRIC LAMPS.

In the lamp of Mr. Killingworth William Hedges carbon rods are prepared so as to render them partially magnetic. He effects this by attaching to the carbons or inserting in them wires or strips of iron, or by compounding with them a proportion of iron filings, or of iron oxide, or magnetic ore, or by depositing on them a thin layer of iron. He places the carbons so prepared in tubes or other suitable guides so that they can slide freely towards each other, or one may be stationary or moved by a weight or spring, or by floatation in opposition to gravity, whilst the other is arranged so as to descend by its own weight towards the former. The lamp provided with one or both carbons, prepared and arranged as described, is operated in the following manner:— At first the points of the carbons being in contact the lamp is put in circuit. The electricity passing freely from the one carbon to the other excites the electro-magnets, or the electro-magnets and the solenoid, when the latter is used, so that the carbon points are caused to separate, and the luminous arc between them is produced. At the same time, owing to the pressure of the carbons against their guides, resulting from the attraction of the lateral electro-magnets, the onward movement of the carbons is impeded until the distance between their points is so far increased by their waste as to reduce the power of the electric current, thereby diminishing the attractive power of the electro-magnets and the drag on the carbons. The carbons thus being left more or less free to move, advance towards each other, lessening the distance between their points, so that the electric current again becomes more powerful and capable of impeding their farther advance. Thus the advance of the carbons to allow for their waste is automatically regulated so as to maintain the distance of their points and the electric force passing through them practically constant. Mr. Hedges also finds that in preparing the carbons by compounding them with iron oxide, as described, he obtains an increased intensity and improved colour in the light. This will be better seen by reference to the diagrams. Fig. 1 represents a side view of a lamp, A and B being the two



magnetised carbons. They rest in guide tubes or troughs, inclined so that the ends of the carbons meet. To each guide is attached an electro-magnet C, the coil of which is in the lamp circuit, and the poles of which are presented towards the side of the carbon guide. Another electro-magnet D, having its coil also in the lamp circuit, presents its pole towards an armature *d*, fixed on the carbon guide B, which is pivotted at *b*, and is acted on by an adjustable spring E so as to bring the lower end of the carbon B against the end of A. When the lamp is put in circuit, the electro-magnets C, C, and D become excited, the two, C, C, attracting the carbons, cause them to bear against their respective guides, producing a frictional hold which prevents them from sliding along them, and the magnet D attracting the armature *d*, causes the ends of the carbons to separate so that the voltaic arc presents itself between them. Should the distance between the ends of the carbons become too great owing to their consumption, then the lessening of the electric power so far weakens the electro-magnets that the carbons are left free to slide and also to approach each other. Thus the distance of the carbons is automatically adjusted to allow for their consumption and for variations in the electric force. A couple of springs F, which meet at their bows with insulating material interposed between them, serve to keep the carbons from slipping down the guides when the lamp is not in circuit, the ends of these springs bearing on them. But when the carbons are separated by the action of the magnet D, the springs F release them and leave them to be held by the attraction of the magnets C, C. Fig. 2 represents a modified arrangement in which there is one electro-magnet arranged with its poles C, C, projecting above the armatures *c*, *c*, on the two carbon guides A and B, both of which are pivotted to the framing. The attraction of C, C, effects the double function of causing the carbons to bear against the guides and also of separating the ends of the carbons. The carbon guides are pressed towards their normal position by blade springs *s*, *s*. Fig. 3 shows a lamp having vertical carbons. The lower carbon A is floated on mercury, which tends to press it upwards, but the attraction of the electro-magnet C^1 operates as a break, preventing its ascent except when the magnetic power becomes weakened. The upper carbon B tends to descend by gravity, but is in like manner impeded by the attraction of the electro-magnet C^2. The poles of C^1 and C^2 are extended sufficiently far to remove the coils of the magnets to a safe distance from the heat of the arc. The upper carbon guide is pivotted at *b*, and carries an armature *d* facing the the electro-magnet D, by which the distance of the carbons is adjusted.





CONTRIBUTIONS TO A PHYSICAL THEORY OF ELECTRICITY.

BY DESMOND G. FITZGERALD.

(CONTINUED FROM P. 34.)

II.

Dynamical Values and Attributes of Matter.

The question as to "electricity" has now been narrowed to the consideration whether there be anything of a substantive nature (as there undoubtedly is a mathematital value, viz.: $\frac{E}{R}$ or $\frac{E}{R_i}$), corresponding to the term, or whether the idea of "electricity" is merely suggested by the effects due to electrical energy ($E\,I\,\theta = Q\,E$), much in the same way as the idea of "fire" is suggested by the effects of heat-energy,

Before entering upon this consideration, it is necessary, in the first place to attach a definite meaning, such as may be generally accepted in the present position of physical science, to contain dynamical terms, the abuse of which has often led to confusion. In defining these terms, I shall aim only at a rough expression of the correct physical notion, or that which may most readily be understood.

Force.

Force, in Physics, is that which tends to produce, produces or opposes the motion of matter: in the first place it is static, or balanced by other force; in the second it is dynamical; in the third it may be termed resistance. Force may always be realised in the mind either as a *pressure* or as a *pull*. Dynamical force is *uniformly accelerating* when it acts independently of the motion it produces, *i.e.*, when it can "follow up" the moving body; otherwise we may have unequal accelerations in equal times, or, in the case where the dynamical force is resisted, we may have uniform motion, or the motion may become retarded, uniformly or otherwise.

Gravity may be said, vaguely, to be a force. The pull of gravity, at a given locality, upon a given mass (or, strictly speaking, between this mass and the earth) is, definitely, a force. This pull is correctly termed the *weight* of the mass, although popularly the term "weight" is applied to the mass itself. Thus, in dynamical expressions, *m* (mass) sometimes represents *f* (weight or force). The pull of gravity, acting through spaces which are inconsiderable relatively to the diameter of the earth, may be taken as a uniformly accelerating force. It is, so far as I know, the only example of such a force in nature.

There are two primary means of measuring forces—a relative and an absolute method. In the former, the pull of gravity

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upon a given mass is assumed as unit force, and the force to be measured is balanced against an equal *weight*. In the latter, the *velocity* which the force, supposing it to be capable of producing uniform acceleration, would produce, *in vacuo*, in unit mass in unit time is calculated, and the force is measured by this velocity.

Forces have hitherto invariably been measured by the *final* velocities obtained under unit conditions. It appears to me, however, that it is preferable, in any absolute system, to measure forces by the *mean* velocities they produce under such conditions; since, if we adopt this plan, the *spaces* moved through by unit mass in unit time will also express the forces. In Appendix I will be found a set of dynamical values and *formulæ* in accordance with this method. This table presents several points of interest, and allows in some degree of a comparison between my method and that ordinarily adopted, of which the corresponding dynamical values are tabulated in Appendix II. Except where otherwise stated, the ordinary dynamical method and formulæ will be adhered to in this paper.

Various units of force have been adopted, some of which are empirical and theoretically indefinite, and others scientific and determinate. Thus the unit of force practically adopted by engineers of our nationality is the *weight* (or the pull of gravity on) the mass called the pound avoirdupois; whilst the unit adopted by continental engineers is the weight of the mass called the gram*.

But the weights of the pound and of the grain vary in different latitudes even at the same level above the surface of the sea; so that if we call w the weight of either of these masses at the equator, the weight at the pole would be $W = w + \frac{w}{196}$, nearly. Again, the weights vary at different heights above the level of the sea; so that, calling W the weight of either of the above masses at the level of the sea, the weight at 1,000 metres above the sea level would be $w = W - \frac{W}{33}$ nearly. The units of force (and work) thus expressed in *gravitation measure*, though sufficiently accurate for most practical purposes, are therefore necessarily inaxact unless certain values (g and h) be stated. Another unit of force is the *poundal*, belonging to the foot-pound-second *absolute* system of measurement—an absolute system being one in which all physical quantities may be referred to a given set of fundamental units as a common scale of comparison. The gravitation unit of force is equal to *about* 32·2 poundals; but the *poundal*, like all absolute units, is perfectly definite. It is the weight of a pound avoirdupois, at any given locality, divided by the velocity in feet which would be generated in one second by the effect of gravity at the same locality. This velocity being the expression, in foot-second units, of the acceleration (g) due to gravity, the poundal is $\frac{1}{g}$ of the weight of a pound. Another British unit of force is that belonging to the foot-grain-second absolute system of units; its value is $\frac{1}{g}$ of the weight of a grain. Besides these, there are the unit of force based upon the metre-gram-second (M G S) absolute system, viz., $\frac{1}{g}$ of the weight of a gram (g being here expressed in metres); and the unit of force belonging to the centimetre-gram-second (C G S) system, viz., the *dyne*, which is $\frac{1}{g}$ the weight of a gram if g be expressed in centimetre-second units.

The C G S system of units is that which was recommended for adoption by the Units Committee of the British Association.† The reason for their selection of the *centimetre* as the unit of length—a selection which at first sight appears a peculiarly unfortunate one—is that the gram is represented by the mass of one cubic centimetre of water at its temperature of greatest density (4° Cent.), and that if the specific gravity $\left(\frac{\text{mass}}{\text{vol.}}\right)$ of water be taken as unity, it must, if we take unit mass as 1 gram, be expressed as $\frac{1 \text{ gram}}{(1 \text{ c-m})^3} = 1$. Thus one centimetre is here the unit length corresponding to the gram as unit mass; but, if we take the metre as unit length, the specific gravity of water must necessarily be $\frac{n \text{ grams}}{n\,(\cdot 01 \text{m.})^3} = 1{,}000{,}000$.

This reason, I apprehend, will have but little weight with practical men, who would much prefer to express the specific gravity of water by the value 10^6 than to employ as unit of length the submultiple of another unit in very general use, and one, moreover, so objectionably small as the centimetre. In the applications of science, at least, it is necessary to strike a mean between scientific and practical expediency; and I imagine that the fullest concession to the former that can be expected from the majority of scientific workers is the adoption of the very beautiful and perfect M G S system of absolute units, in lieu of the units of gravitation measure represented by the engineer's *foot-pound*. Even the latter have not yet had their day; and there is some danger of our maintaining our "insular isolation" by the adoption in their stead of an absolute system of measurement based upon British fundamental units. For, although I can only characterise our commercial system of weights and measures, with their polyform multiples and submultiples, and differing units of the same denomination, as detestable, it is to be observed that the objections to this latter system do not generally apply to an absolute system based on some of its units.

APPENDIX I.

DYNAMICAL VALUES.

UNIFORMLY ACCELERATED MOTION OF UNIT MASS.

t.	$v = 2ft$	$s = \frac{v}{2}t = ft^2$	$fs = F^2 = \frac{W}{m}$	$\left(\frac{v}{2}\right)^2 = \frac{W}{m}$

UNIT FORCE.

(Defined as producing unit *mean* velocity $\left(\frac{v}{2}\right)$, or movement through unit length, in unit mass in unit time.)

1 second	2	1	1	1
2 seconds	4	4	4	4
3 ,,	6	9	9	9
4 ,,	8	16	16	16

QUADRUPLE FORCE.

1 second	8	4	16	16
2 seconds	16	16	64	64
3 ,,	24	36	144	144
4 ,,	32	64	256	256

Force = pull of gravity, at London, on a mass of one gram. Measured by the mean velocity $\left(\frac{v}{2}\right)$ generated, or by the space moved through, in unit time. Or $f = g = 4{\cdot}9055$ abs. metre-gram-second units of this system $\left(\frac{\text{ordinary M.-G.-S. units}}{2}\right)$.

1 second	9·811	4·905	24·059	24·06
2 seconds	19·622	19·622	96·245	96·25
3 ,,	29·433	44·149	216· 55	216· 5
4 ,,	39·244	78·488	384· 98	384· 9

Here f = accelerating force measured by the mean velocity or the work produced by its acting freely on unit mass during unit time; $ft = F$ is the mean force in action during the time t; m = mass; and $mf^2t^2 = F^2m = m\left(\frac{v}{2}\right)^2$ is the kinetic energy stored up. The metre-gram-second units of force and work on this system have double the value of the ordinary M.-G.-S. units, *i.e.*, they equal $\frac{\text{gram-metres}}{4{\cdot}9055}$.

APPENDIX II.

DYNAMICAL VALUES.

UNIFORMLY ACCELERATED MOTION OF UNIT MASS.

t.	$v = ft$	$s = \frac{v}{2}t$	$fs = \frac{W}{m}$	$\frac{v^2}{2} = \frac{W}{m}$

UNIT FORCE.

(Defined as producing unit velocity in unit mass in unit time.)

1 second	1	½	½	½
2 seconds	2	2	2	2
3 ,,	3	4·5	4·5	4·5
4 ,,	4	8	8	8

QUADRUPLE FORCE.

1 second	4	2	8	8
2 seconds	8	8	32	32
3 ,,	12	18	72	72
4 ,,	16	32	128	128

Force = pull of gravity, at London, on mass of 1 gram; or $f = g = 9{\cdot}81$ in absolute metre-gram-second units.

1 second	9·811	4·905	48·12	48·12
2 seconds	19·622	19·622	192·48	192·48
3 ,,	29·433	44·149	433·15	433·15
4 ,,	39·244	78·488	770·03	770·03

(TO BE CONTINUED).

* Following the example of some other writers, I have taken the liberty of anglicising this term.

† This committee was originally composed of Sir W. Thomson, F.R.S.; Professor C. G. Foster, F.R.S.; Professor J. Clerk Maxwell, F.R.S.; Mr. G. J. Stoney, F.R.S. (who alone objected to the selection of the *centimetre* as the unit of length); Professor F. Jenkin, F.R.S.; Dr. Siemens, F.R.S.; Mr. F. J. Bramwell, F.R.S.; and Professor Everett.

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THE ELECTRIC LIGHT.

It is necessary from time to time to take a retrospective look at the various phases which occur in the attempt to introduce an improvement which really constitutes a radical departure in the history of everyday convenience. The electric light is such an improvement, and the steps in its career are as well defined as those which depict the onward progress in the life of an individual; yet its introduction agrees with Bacon's dictum relating to innovations. He said, "It were good, that men in their innovations would follow the example of time itself, which indeed innovateth greatly, but quietly, and by degrees scarce to be perceived; for otherwise, whatsoever is new is unlooked for; and ever it mends some and pairs (impairs) other; and he that is holpen takes it for fortune and thanks the same; and he that is hurt, for a wrong, and imputeth it to the author." The electric light is progressing quietly but none the less effectively, and its gradual use fails to excite that alarm which was so evident during the first attempts to practically illustrate its utility. We do not believe there are many well authenticated cases where the introduction of good apparatus of any kind really did much harm to vested interests. Undoubtedly there must be a change, but it is almost always gradual, and means that new capital is not brought into the old ways, that labour is directed into a new channel. It seems to us that the innovation, if it be a real improvement, opens out ways and means for a larger capital and a greater expenditure of labour than the state it supersedes. The domain of gas is far more extended than was that of oil, and although at present the electric light cannot compete successfully with gas at every point, the time will come, brought about by a series of gradual improvements, when the domain of the electric light will surpass that of gas even in as great a ratio as the latter surpasses oil. Though, so to speak, gas in a measure superseded oil, there is at the present time more oil used than was the case in its palmiest street-lighting days; and so it will be with gas. Its sphere is at present partially undeveloped, and will remain so till its strongholds are attacked and subdued by its rival.

The successes of the electric light in new directions are all its most strenuous supporters can wish. One week we find it tried on one steamer and pronounced good, the next we hear of a more extended trial on another steamer, with a promise that if it fulfils the requirements it will be adopted for the whole of a powerful fleet. That we are not exaggerating will be seen from the following:—"The Inman Company's royal mail steamer City of Berlin, Captain Kennedy, sailed from the Mersey yesterday for New York, fitted with the electric light throughout the whole of the passenger deck, both saloon and steerage. Experiments were made on Wednesday evening on board the vessel as she lay in the Mersey prior to sailing, with a view of testing the adaptability of the light for ships' purposes, and these were repeated yesterday morning in the saloon and lower deck, which had been darkened for the occasion. The results were thought to be so satisfactory that the electric light will be used on the passage to New York, and if, after this extended trial, it is still found to answer it will be adopted in all the vessels of Messrs. Inman and Co.'s fleet." We hope that the results will give complete satisfaction, for one of the most intolerable discomforts on board ship to the ordinary passenger has been the smell of oil lamps. Any improvement in this direction will be heartily welcomed.

In another column we give a short report of the action taken by the Hull Town Council. Here will be seen another decided step in advance. Notwithstanding the failures last session, an important town has decided to "apply to Parliament for a bill enabling the Corporation to obtain all necessary powers for lighting the borough and adjoining districts by means of electricity." There is probably no place so well able to gauge the merits of the electric light as a busy seaport. Generally the streets of such places near the quays are narrow, wretchedly lighted, and blocked by an enormous traffic.

The better the light, the better for all business purposes, and when it is necessary to work double tides the quays may be illumined as with the full moon, so that ships can be loaded or unloaded with little difficulty. It is in such places that the best light obtainable is required, and even if the cost should at first be greater than that of the ordinary gas

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light, with which it is always compared, in the long run the return obtained because of its use will more than compensate the outlay. It is different with small inland towns, the business is practically finished at sundown, and the street lamps are of use only to guide the visitor to the door of his host, and back again to his own house.

We must not in this place forget to mention the gradual introduction of the electric light into the operations of war. Forts and ships are supplied with apparatus, and the attack as well as the defence is fast developing a new system. One moment all is darkness, the next the whole scene is brilliantly illumined, so that the swiftest torpedo launch has no chance of escaping beyond the glare that can be thrown upon it. The manufacturers of electric machines could tell us, if they cared to do so, how extensive has become the demand for these machines for warlike purposes. The *impedimenta* of the army of the future will contain electric light apparatus for signalling purposes. The heliograph is dependent on the sun in the daytime, but signalling is required as much by night as by day. The Morse or any similar alphabet where periods of light and darkness stand for dots and dashes, supplies the language—and with a knowledge of such a system two people can communicate, without much danger of foreign intervention, as far as the concentrated rays can penetrate.

EXPERIMENTAL RESEARCHES ON THE ELECTRIC DISCHARGE WITH THE CHLORIDE OF SILVER BATTERY.

By Warren De La Rue, M.A., D.C.L., F.R.S., and Hugo W. Muller, Ph.D., F.R.S.

Received August 7, 1879.

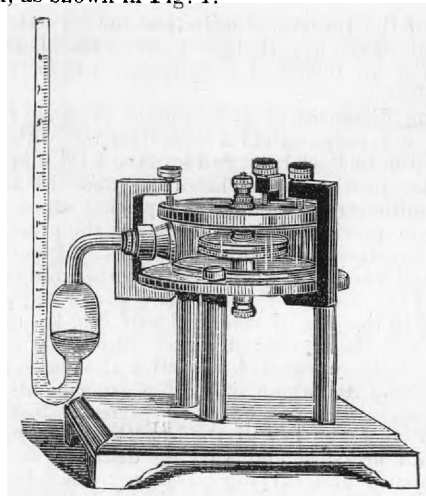
(Abstract.)

Part III.—*Tube-Potential; Potential at a Constant Distance and Various Pressures; Nature and Phenomena of the Electric Arc.*

In the first part of this paper the authors describe a series of experiments to determine the potential necessary to produce a discharge in a tube, exhausted gradually more and more while using a constant number of cells in all the experiments. In consequence of the life of the battery becoming so much exhausted by the method employed, the experiments were confined to one gaseous medium, namely, hydrogen. Since the completion, however, of the measurements described in the paper, the authors have found two other more convenient methods for determining the tube-potential, which do not exhaust the battery injuriously; these are described in an appendix. The tube, 162, employed was 33 inches long and two inches in diameter, the distance between the ring and straight wire terminals being 29·75 inches; the battery consisted of 11,000 cells. The discharge took place when the pressure was reduced to 35·5 mm., 46,710 M, and the exhaustion was afterwards continued gradually until it fell to 9·0065 mm., 8·6 M. In commencing each set of experiments the deflection of a tangent-galvanometer was observed when the battery was short-circuited. By a table previously calculated, the value of the deflection in ohms of resistance per cell could be read off; this multiplied by 11,000 gave the total resistance of the battery; the tube was then connected with the terminals and the galvanometer again observed; this gave a less deflection and indicated a greater resistance, which, multiplied by 11,000, gave the total resistance of the tube and battery; by subtracting the resistance of the battery the resistance of the tube was ascertained. Calling the total resistance R, the tube resistance r, the tube-potential V, $V = \frac{r \times 11{,}000}{R}$. The tube-potential requisite to produce a discharge, with a pressure of 46,710 M, was found to be 10,250 cells; this gradually fell until a pressure of 0·642 mm., 1,082 M was reached, the tube-potential being then only 430 cells, after which it rapidly rose, and at 8·6 M it required a potential of 8,937 cells to produce a discharge. From the experiments described in Part II. (p. 103, foot note), it was found that in another tube it required the full potential of 11,000 cells to produce a discharge at 3 M, and that at 1·8 M this potential was insufficient. The obstruction to the discharge in tube 162 was as great at 8·6 M as at 28,553 M pressure, and required 8,950 cells in each case. A few of the more remarkable phases of stratification in tube 162 are shown in one of the plates which illustrate the paper.

The next part of the paper deals with the potential necessary to produce a discharge between discs 1·5 inch in diameter, at a constant distance and at various pressures.

In the first instance an experiment was made in order to ascertain whether there was either any condensation or dilatation of the gas in contiguity with the terminals before the actual passage of the discharge. In order to do this an apparatus was constructed, as shown in Fig. 1.



It consists of a glass cylinder, the depth of which is accurately the same in every part, so as to ensure the parallelism of two glass discs which close its ends.

These are held in contact with the ends of the cylinder by means of screw-clamps made of ebonite, and the whole apparatus is supported on a tripod ebonite stand, which is fastened to a square wooden foot. Attached parallel to the top and bottom glass discs, by means of flanged-screw rods, are two brass discs with rounded edges, 4 inches in diameter; these are maintained at a distance of 0·13 inch, 3·3 mm., at which the discharge of 11,000 cells would only just take place.

The ends which project through the glass discs are furnished with binding-screws for attaching wires from the battery.

On the side of the cylinder is a tubulure in which is fitted a gauge containing strong sulphuric acid, so as to dry the inside of the apparatus, and to indicate whether any condensation or dilatation of the gas contained in the cylinder occurs on connecting the metallic discs with the battery by means of the contact-key. The edges of the cylinder were rubbed with grease, and care was taken to prove that the apparatus was perfectly tight, by causing the fluid in the limb of the gauge to stand for some time higher than that in the bulb. When contact was made with a battery of 9,800 cells, there was not the slightest indication of any alteration of volume of the contained air, so that there was neither condensation about the discs which would have caused a contraction nor repulsion from the discs which would have caused an expansion of volume. The fluid in the stem was observed with a lens, but not the slightest motion of it took place. The same result was noticed even when water was substituted for sulphuric acid. So far, then, as this apparatus would indicate it, the result is entirely negative.

Potential necessary to produce a discharge between discs at a constant distance and at various pressures.

The experiments were made by placing the micrometer-discharger, Part I., Fig. 1, under a bell-jar, and in the first instance adjusting the discs to the striking distance at atmospheric pressure for the battery of 11,000 cells. Afterwards a less number of cells was connected with the discs and the bell-jar gradually exhausted until the discharge occurred; the height of the gauge was then read off. Then a less and less number of cells was connected with the discs and the operation was repeated. There was a gauge about 36 inches long attached to the pump-plate in order to indicate the pressure beyond the range of the gauges attached to the pumps.

In air the discharge took place at ordinary atmospheric pressure with 11,000 cells when the discs were 0·13 inch, 3·3 mm. distant; and with 600 cells at an average pressure of 10 mm.

In hydrogen it took place at atmospheric pressure with 11,000 cells when the discs were 0·22 inch, 5·59 mm. distant; and with 600 cells at an average of 14 mm. pressure.

In carbonic acid, at atmospheric pressure with 11,000 cells,

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when the discs were 0·122 inch, 3·096 mm. distant; and with 600 cells at an average pressure of 5·2 mm.

The numbers obtained for air, hydrogen, and carbonic acid respectively were plotted down on millimetre scale paper, the abscissæ being 1 mm. = 2,500 M, the ordinates 1 mm. = 25 cells, and curves drawn to give a mean of the several observations. These appeared to resemble hyperbolic curves so closely that true hyperbolic curves were found partly by a geometric construction, partly by computation, which would intersect the mean experimental curves in two points. The results of experiment were again laid down on these new curves, and it was found that they did not differ more from them than they did from each other.

The ratio of the transverse axis (pressure) to the conjugate axis (potential) of the hyperbolas set out on the above-mentioned scale, was—For air 0·9665, for hydrogen 1·0170, for carbonic acid 1·0690.

The striking distances at atmospheric pressure for spherical surfaces 3 inches radius and 1·5 inch diameter, with various potentials, as given in Part I., page 14, curve VIII., and at page 64, also those for nearly flat surfaces in pages 19 and 64, were reduced to millimetres distance and plotted down in the same way, but not on precisely the same scale as the preceding curves for constant distance and various pressures. Hyperbolic curves were also found which intersected the experimental curves in two points.

It was seen in the case of spherical surfaces, the result having been obtained as the average of a great number of experiments, that the hyperbola coincided closely with the observations, while for plane surfaces, for which only a few experiments were made, the coincidences were not quite so perfect. Nevertheless, it would appear that the law of the hyperbola holds equally well for a constant pressure and varying distance as it does for a constant distance and varying pressure; the obstacle in the way of a discharge being up to a certain point as the number of molecules intervening between the terminals.*

In the two cases of spherical and plane surfaces the ratio between the transverse (distance) and conjugate (potential) axes of the respective hyperbolas was—For spherical surfaces 1·240, discs 1·285.

(TO BE CONTINUED.)

THE SOCIETY OF TELEGRAPH ENGINEERS.

The annual meeting of this Society was held on Wednesday last, in the theatre of the Institute of Civil Engineers, to elect president, vice-president, and council, to receive the report of the Council, and to hear a paper by Mr. March Webb on the operations connected with the laying of the Marseilles-Algiers Cable.

The report of the Council stated that the number of members, including those elected that evening, was 1,019, consisting of 41 honorary members, 157 foreign members, 329 members, 506 associates, and 13 students. Mention was made of the loss sustained by the society by the death of Sir W. Fothergill Cooke, James Clerk Maxwell, and Mr. Brough. An exhaustive memoir of the first-named gentleman was appearing in the *Journal*, contributed by Mr. Latimer Clark, and in the last number Mr. Schwendler has contributed a short memoir of the late Mr. Brough. The report then referred to the late Conference, and to the papers read at the sessional meetings of the institute. Their wire gauge committee had carefully studied the question of wire gauge, and was almost prepared to submit its report to the Associated Chambers of Commerce and the Board of Trade, both of which promise to consider the subject in an exhaustive manner. The committee inaugurated under the auspices of the Meteorological Society to consider the question of lightning conductors, was also almost ready with its report.

The catalogue of the Ronalds Library was progressing satisfactorily. The work in connection with it was very great, but some hundreds of pages had been finally corrected and printed off. The number of subscribers might be larger. The binding of the library again was going on satisfactorily, thanks to the donations handed over by the donors for this object from the excess of the Conference fund.

The Council had it under consideration to obtain a charter for the Society, and then it might hold a better position to have a claim in the proposed building for several learned societies, which was under consideration owing to the promise of their Past President, Dr. Siemens, to contribute £10,000 towards such an object.

It was also under consideration, and it was hoped a proposition would soon be made to give a wider scope to the proceedings of the Society. Unfortunately the public idea of the work of the Society was that it was limited in extent, but a reference to their regulations would have shown this to be fallacious. The idea, however, had such depth that the Council hoped by the method to be proposed would place the qualifications necessary for members on a clearer footing.

The financial position of the Society was satisfactory, their printing had been done in a more economical manner, and one-third of their debt liquidated. More would have been paid, but that the arrears of members' subscription were large.

The report was adopted.

The ballot taken for new members of the Council resulted in the election of Prof. Hughes, Mr. Stroh, and Mr. C. F. Varley, F.R.S., and Mr. Adams, Mr. M'Gregor Greer, and Mr. J. G. Hill, as associate members of the Council. The President for the next session is W. H. Preece, C.E.

The operations connected with the laying of the New Marseilles-Algiers cable:—

Mr. March Webb stated that in June, 1871, the India Rubber, Gutta Percha, and Telegraph Works Company, laid a cable for the French Government from Marseilles to Algiers. Only two types of cable were used, a light shore end, single sheating of 12 No. 5 galvanised iron wire, weighing 4½ tons per knot, and a deep-sea, sheathed with 16 No. 13 homogeneous wire, weighing about 1½ tons per knot, with a conductor of 7 stranded No. 22 copper wire. This cable was satisfactorily laid, and afterwards duplexed, but through increase of traffic a second cable became necessary. The French Government sought tenders, and that of the India Rubber, Gutta Percha, and Telegraph Works was successful.

Some important extracts from the specification were given, thus—The conductor resistance must not exceed 12 ohms per knot at 75° F. The electrostatic capacity per knot must not exceed .4 microfarad; the insulation resistance per knot at 75° F after 1 minute charge must not be less than 200 megohms. The conductor to be of 7 stranded copper wires, and to weigh 106lbs. per knot. The insulating material to be 3 coatings of gutta percha, weighing 139lbs. Total weight of core being 245lbs. per knot. The deep sea cable consists of 15 homogeneous wires No. 13 gauge, with a minimum breaking strain of 5½ tons and weight per knot 1·58 tons; the intermediate of 10 galvanised iron wires No. 6, with a minimum breaking strain of 6 tons, weight 3·16 tons, the shore end of 10 No. 0 galvanised wire, with a minimum breaking strain of 15 tons and weight per knot 10 tons. The galvanising was tested by four successive immersions of 1m. each in a solution of 1 Cu SO_4 to 5 of water. A description of the ss. Dacia, designed originally by Sir C. Bright, was given, and it seems the ship is admirably adapted for the work she has to perform. Various exceptional arrangements in the gear were mentioned, such as the automatic dynamometer showing the varying strains, and an exceeding simple and efficacious break, originally designed by Sir C. Bright or Mr. Matthew Gray (the discussion left this matter in doubt, Sir C. Bright claiming it and Mr. F. C. Webb advocating the claims of Mr. Gray), with improvements by Mr. F. C. Webb. The shore end of the cable was successfully laid at Algiers on September 16. Before the main cable was laid, a systematic course of soundings was made along the proposed route, no less, indeed, that 143, of which the Dacia made 93. The Dacia is fitted with a modification of Sir W. Thomson's pianoforte wire sounding apparatus, and by means of this apparatus the soundings were easily and quickly made, soundings in deep water taking not more than from 20 to 30 minutes. At night the operations were greatly facilitated by the use of the electric light. The Dacia carries two engines of 5 h.-p. each, working two Gramme machines. The lamps used are a modified Serrin and the one known as the "Silvertown Hand Regulator." The greatest possible praise is given by all connected with the work as to the utility of the electric light. The author proceeded to describe in detail other interesting pieces of apparatus, which, however, require diagrams in order to make them understood, such, for example, as the clockwork arrangement for continuity signals between ship and shore. (The paper was well illustrated by means of diagrams, charts, and specimens of apparatus used.) The laying of the cable was very successful till a link of the chain of the buoy attached to the intermediate cable broke, at the time when the whole operation was at the point of conclusion. Some difficulty was experienced

* Dr. Alexander Macfarlane has published in the "Transactions of the Royal Society of Edinburgh," 1878, vol. xxvii, an elaborate and careful research of the "Disruptive Discharge of Electricity" in air and different gases, and between terminals of various forms. An abstract of this paper will be found in "Nature," December 26, 1878, pp. 184, 185. Dr. Macfarlane used a Holtz machine and employed higher potentials than those we used; he found that the results for the discharge between two discs four inches in diameter at various distances up to 1·2 centims. and with various pressures were satisfactorily represented by the hyperbola.

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in grappling the lost end, from the rocky character of the sea bottom at that place. Ultimately it was found, the splice made, and the cable laid.

The discussion of the paper was carried on by Colonel Thomson, Mr. F. C. Webb, Mr. Phillips, Sir C. Bright, Mr. W. H. Preece, and Mr. Willoughby Smith.

Mr. W. H. Preece was present during the operation of laying the cable, and spoke in high terms of praise as to the method in which the work was carried out. He advocated at some length a systematic survey of the sea bed.

A hearty vote of thanks was given to Mr. M. Webb for his paper, and to the Silvertown Company for allowing details of work hitherto kept secret to be brought before the Society.

CORRESPONDENCE.

EDISON'S ELECTRO-GENERATOR.

TO THE EDITOR OF THE ELECTRICIAN.

(TRANSLATION).

Paris, 22nd November, 1879,
57, Boulevard Courcelles.

SIR: On page 293 of your issue of the 29th inst., you publish two letters from persons who have not correctly apprehended the bearings of the new arrangement adopted by Mr. Edison in his new magneto-electric machine for the production of light.

In the short note appended by you, the mistakes of your correspondents were in part indicated. Allow me to request hospitality in your columns in order to completely elucidate this question. It is to be observed that the machine in question had been predicted as early as the 15th August last, on page 94 of "La Lumière Electrique," in one of the articles entitled "From Electricity to Light," signed "Gessé."

Your correspondents have considered the expression for the work of under the form of

$$W = 10 \frac{E^2}{R} \text{ meg-ergs.}$$

Nothing could be arrived at from the expression in this form, since E cannot be considered as fixed when R is varied. In the case that was to be studied, the work should have been expressed under the form of

$$W = 10\ C^2\ R \text{ meg-ergs.}$$

In effect, every electro-generator acting by induction should be investigated from the point of view of its maximum duty in external work, and also from the point of view of the ratio of this useful work to the total work expended; in the studies signed "Gessé" these values are termed the *absolute maximum duty* and the *relative maximum duty*. The distinctive point in an induction machine relates to the maximum intensity of current that can traverse its internal coils without damaging them; so that if we take the formula $W = 10\ C^2\ R$ meg-ergs, and consider the conditions of the absolute maximum duty, C will be the distinctive point in question. If we divide the total resistance into internal and external resistance, the formula becomes, according to the usual notation—

$$W = 10\ C^2\ (r + R) \text{ meg-ergs.}$$

In a given machine, C and r remain constant, and the total work will augment when the external resistance is increased, as shown by

$$W = 10\ C^2\ r + 10\ C^2\ R.$$

This formula renders it clear that, when the current in circulation is maintained constant, or so long as the conditions of maximum duty are adhered to, and when the external resistance is progressively augmented, the thermal work confined to the interior wire of the machine will remain constant, and the thermal work regenerated externally will augment proportionally to the external resistance. It is of course understood that in order to remain under the conditions of the absolute maximum duty, with different values for the external resistance, the electro-motive force E must each time have varied, as well as the velocity of the movable coils. In the special case where the inductors are independent of the circuit, the velocities and the electromotive forces corresponding to two different values will be almost exactly as the resistances. That is to say:—

$$\frac{V}{V_1} = \frac{E}{E_1} = \frac{r + R}{r + R_1}$$

It will be understood that the number of foot-pounds absorbed from the mechanical motor will be different in each case, and be such as to satisfy the proportion—

$$\frac{W}{W_1} = \frac{r + R}{r + R_1}.$$

Thus it is incontestable that the absolute maximum duty, $10\ C^2\ R$, will augment proportionately to the external resistance, and that the absolute relative duty, $\frac{10\ C^2\ R}{10\ C^2\ (R + r)}$, or $\frac{1}{1 + \frac{r}{R}}$, will also be much increased as the external resistance is augmented.

As a numerical exemplification of what I have just said, I may observe that the work absorbed from the mechanical motor when the external resistance is nine times greater than the internal would only be five times greater than that absorbed when the external resistance is equal to the internal; whereas the thermal work utilised would be nine times greater. We must therefore render justice to Edison's arrangement as a good one, and we must also admit that there must be something of novelty in it; since certain persons, unable to realise the possibility of a more extended utilisation, believed it at the outset to be a manifest absurdity.

If I had to explain why the view in question, being correct, may also be new, I should point out, on the one hand, that it has been attempted without sufficient consideration to apply to induction machines the conditions of maximum classically taught in relation, for instance, to voltaic batteries, that is to say to generators in which the electromotive force is naturally a fixed value; whilst in the induction machines it is essentially variable at will. On the other hand I would point out that the union of the inducing and induced circuits, rightly regarded as being in certain cases a progress, has in fact been an obstacle to the above arrangement in other cases where it would have been desirable. I may say, moreover, that, if this adaptation of Edison is good in the special case which he has in view, in which the machine works through a constant resistance, constituted by a series of irridio-platinum lamps, it would have been dangerous in the applications of the electric light realised up to the present time, by means of the voltaic arc. For, in spite of the endeavours of the constructors of electric lamps and burners, it is with good foundation considered that the voltaic arc is susceptible of considerable accidental variations in its electrical resistance; so that, even with separate inductors, a notable diminution of resistance, such as that determined by contact of the carbons, may occur and might produce a deterioration of the machine, especially where the specific utilisation of the induced wire has been best carried into effect. I will conclude by saying that, under the same circumstances in which Edison is placed, the same principles may be applied to various known systems of induction machines, and the same advantages may be derived from them.—

Yours truly,

C. CLAMOND.

TO THE EDITOR OF THE SCIENTIFIC AMERICAN.

A communication in No. 20, page 305 of this volume of your paper, headed "Edison's Electrical Generator," requires a few words of explanation.

Special pains are there taken to imply that the writer of an article on this machine in No. 18 either had been deceived, or was trying to deceive others by statements which were made regarding the machine. The writer of the account simply stated that the machine was so constructed that when used at its normal capacity the external resistance should be nine times as great as the internal, so that ninety per cent. of the power in the current could be used outside. No fuller statement was made, since Mr. Edison preferred to wait until he had made some improvements that his experiments had shown were necessary. Yet all that was claimed in the article was perfectly true, and has been carefully verified.

The statement that one man could maintain the arc of a Jablochkoff candle was made after trial. It was found by careful tests with a Prony dynamometer that a man could exert for a short time about one-half a horse power, and that for the same time he could maintain an arc equal to that from a Jablochkoff candle. This test was made for the purpose of showing beyond all question that the power requisite for a good light need not be very great.

In illustrating the action of electricity in the circuit, Dr. Seeley wisely remarks and kindly explains how that "beasts of burden and other rational creatures redouble their efforts when their burdens are increased, while electricity behaves very differently, as there are no moral suasions or reserved forces behind it." Yet the learned doctor of philosophy, in saying this, reminds one of the bright scholar he mentions, "whose vision, though very clear, is not so wide, who is quick to spy out a thing, yet does not observe its environments." It seems never to have occurred to the doctor that it is in the power of the maker of the machine to exert this "moral suasion" on the wire covering the armature, so that it shall be more effective, and redouble its exertions when greater resistance is offered for it to overcome.

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Suppose, for example, a machine was made so as to run on short circuit having one unit of resistance within the machine, from which was given off a certain amount of energy. If the wire on the armature could be made four times as efficient, three units of resistance could be placed outside, and yet each unit would give off the same energy as did the one in the machine in the first case. If the wire could be made nine times as efficient, nine times the resistance could be placed in the circuit, and still have each unit as active as in the first case. Mr. Edison, by using large magnets, has done this; that is all he claimed, and all that the writer of the article which provoked this discussion expressed. He was perfectly aware of the fact that the friction of the machine and local action counted more in proportion as the resistance in the circuit was increased. Yet he felt contented so long as the tests which I made for him showed that less was lost than in any other machine in transferring mechanical into electrical energy. His machine is so made that it would be impossible to use it with the same resistance outside as inside, as it would heat the wire on the armature so as almost to burn it, by carrying a current so much in excess of that for which it was intended.

The reader, whom Dr. Seeley advises so glibly to wrestle with Ohm's law until he has mastered it, may, when he begins, take the doctor as a pupil, and show him that he has wrongly applied the simplest equation, expressing it $C = E R^{-1}$. "I am grieved to observe that many people who talk and write glibly about electricity do not understand it," and no better illustration can be found than in a doctor of philosophy deliberately stating that current and foot pounds are the same, or that energy is directly proportional to the current. Foot pounds are always measured by the square of the current, and the method of measuring is analogous to that employed for measuring the energy in a stream of water. For if twice the amount of water flows from a given sized jet against a turbine, it will be able to do four times the work, for each particle of water will be moving twice as fast and thus be twice as energetic, and there will be two times as many of them. Although Dr. Seeley has used the water analogy he has failed to see its "environment."

Dr. Seeley's distinction of outside from inside current seems to me ridiculous, for it is exactly similar to saying that an endless wire rope running from a building out of doors has an outside and an inside velocity. The current means the rate of flow of electricity, and must be the same for the whole circuit, so that the "outside and inside currents" must always be the same.

In conclusion, I may state that the methods which are employed for testing Mr. Edison's machines were fully described in a paper read by me at the Saratoga meeting of the American Association. At that time, as now, full results were withheld until Mr. Edison was fully satisfied with the performance of his machine.

To show the line of experimenting he has chosen, it may be mentioned that he hopes soon to have a machine with only one-eighth of an ohm in the armature, which he will use with an external resistance twenty times as great, and which shall give with less than one-tenth of a horse power on the magnets an electromotive force of 100 volts. FRANCIS R. UPTON.

Laboratory of T. A. Edison, Menlo Park, N. J.,
Nov. 11, 1879.

CANTOR LECTURES.*

RECENT ADVANCES IN TELEGRAPHY.

By W. H. PREECE, Electrician to the General Post Office.

LECTURE IV.

(CONCLUDED FROM PAGE 29.)

Now, we have duplex working going on with our old friend the tapper, and you can hear the dots and dashes being given by the sounder, while something is also being sent to T S.

[T S then sent the message, "Latest from the Cape. The Boers' camp is broken up, and they have returned to their homes."]

I mentioned to you that one cause of disturbance in working duplex is due to variations in insulation. Another cause is due to variations in temperature. In some countries, where extremes of temperature occur, very great difficulty is found in working duplex, and even the passage of a cloud across a wire may produce sufficient variation to alter the balance between the two currents. Again, there is another cause of variation of working due to what are called "earth currents."

At certain seasons of the year, and at certain periods, there are strong currents of electricity flowing through the earth, and these currents enter our wires and produce disturbance. Where they come from, or what they are, we do not know; it is one of the mysteries of telegraphy, and although theories have been propounded, there is only one theory really that gives us the slightest clue to the cause, and that is a "new theory of terrestrial magnetism" by Professors Ayrton and Perry. Again, thunderstorms disturb the wires by producing what are called "kicks." Currents pass over the wires and break up a dash into two dashes, or they wipe out a dot, or put in a dot, and produce disturbances in this way; and it almost invariably happens that, when a thunderstorm is prevalent in Ireland, that the duplex circuits passing through South Wales and Haverfordwest are disturbed by these currents. In order to counteract all these disturbances due to insulation, changes of temperature, and so on, the artificial line which is marked R, or resistance, or *rheostat*, on the diagram, is varied. A box of this kind is so constructed that, as the line varies, so we can produce a similar variation upon our artificial line. Suppose, for instance, a wire going from London to Birmingham, and a severe rainstorm passed over Watford and reduced the current coming from Birmingham; all we should have to do would be, to put in one of those pegs of the *rheostat*, as it is called, and that would compensate exactly for the variation produced by the rainstorm. Or, suppose that a severe storm were suddenly followed by bright sunshine, then a balance is at once produced by taking out one or two of these pegs; and so, by watching the working of results, by looking out for these disturbances, and by holding the pegs of these artificial lines, we are able to keep the artificial line exactly the same electrically as the working line, and so maintain the balance or state of neutrality in our sending instruments.

There is another difficulty that rather disturbs the working which I have not referred to, because it does not interfere with the principle of the thing, but on our lines we meet with a disturbance that is called "static induction." It is a hard word, and I do not want to use hard words if I can help it, but static induction means this, that the current seems to meet with what is almost analogous to friction in water or in gas passing through a pipe. Some people call it a kind of "sticktion." If you force water through a pipe some of it sticks to the sides of the pipe by attraction, and remains there, and so when you pass a current of electricity through a wire, a portion of it remains adhering to the wire, owing to the presence of this static induction, and the existence of this static induction was the real reason why duplex working was so long before it was introduced. I will mention that, when I speak of the history of duplex, I want merely to point out now that there exists this disturbance, and that it is compensated for by what are called condensers. Condensers are merely Leyden jars, and by their means the artificial line is balanced to equal the effect of the static induction on the line, and so the currents passing through are made equal and neutralised. But it is in submarine cables where this disturbance is chiefly felt, and I will allude to that little further on. It may be interesting to mention that we have in England now no less than 320 circuits working duplex on a system similar to what you see here, and the average length of each country circuit is about 150 miles, so that we really have about 48,000 miles of wire in this country working duplex, and the introduction of duplex working within the last seven years has been equivalent to the erection of 48,000 miles of wire.

Again, the work done over a duplex circuit is really more than double what an ordinary wire can do. For instance, supposing a wire can convey 20 messages an hour, by duplexing you can carry 50 messages an hour, more than double, because there is no interference from questions being asked, or from repetitions being made, but the work passes in both directions from Birmingham to London, and London to Birmingham, all day long, without any let or hindrance; and this equable flow really means more than double the amount of work. The progress of this duplex working was slow. It was invented in 1853 by Dr. Gintl, in Vienna, who, I believe, was in the service of the Telegraphic Administration of Austria. It was he who first introduced the compensation principle, but in 1854, Frischen, of Hanover, and Siemens and Halske, of Berlin, introduced this principle that I have explained to you to-night, which differs a little from Gintl's. Many others have tried various kinds of duplex; in fact, I heard an electrician once say, that "knowing how to work duplex it would be quite possible to invent a new duplex every week." I do not believe that, but at the same time, the numbers of systems of duplex that are in use are very great. From 1855 to 1868 duplex was what many things have been, simply a scientific toy. It had been proved to be practicable, it had been tried, but it had not been used, principally because it was not wanted. But in the year 1868 Mr. Stearns, a very distinguished American electrician (who was the head of one of the telegraph companies in America, and who I have no doubt is in this room to-night, although I do not see him), had his attention attracted to the subject, and he found what was really the cause of the difficulty in working duplex, and that was the existence of the electro-static induction upon the line. When once you find the cause, it is very easy to find the remedy; and by introducing condensers such as are upon the table into the artificial line, Mr. Stearns succeeded in compensating for static induction, and by that means made duplex telegraphy what it now is. It is, however, in working cables generally that duplex becomes of such service. Many of the cables belonging to the Eastern Telegraph Company, in the Mediterranean, in the Red Sea, and across the Indian Ocean, have been duplexed by Mr. Muirhead. It is only lately that the Atlantic cable has been duplexed by Mr. Stearns himself, and he has done it with wonderful success. I have in my hand here two slips that were made only two or three days ago, specially for illustration before you this evening, and which read "This is a specimen of Stearns's duplex working of Atlantic cable at about twenty-five letter words a minute." The ordinary rate of working the Atlantic cable, when I was there, was about fourteen or fifteen words in one direction, now it works twenty words in each direction, so that the capacity of the cable by the application of Mr. Stearns' principle has really been to increase its capacity more than twofold.

I cannot occupy your time by referring to the various systems of duplex. There is a very pretty system by Mr. G. Winter that is in use in India, and also largely in America, where it is known only under the name of D'Infreville. It has been applied by Mr. Fahie in Persia. But we have recently been trying another form of duplex here, the invention of Mr. Theiler, which dispenses with the second current by mechanical means. Mr. Stearns, in 1872, also applied mechanical means to compensate, as did also Mr. Gerritt Smith in America. There is no great value in it; I merely

* From the *Journal of the Society of Arts* for October, 1879.

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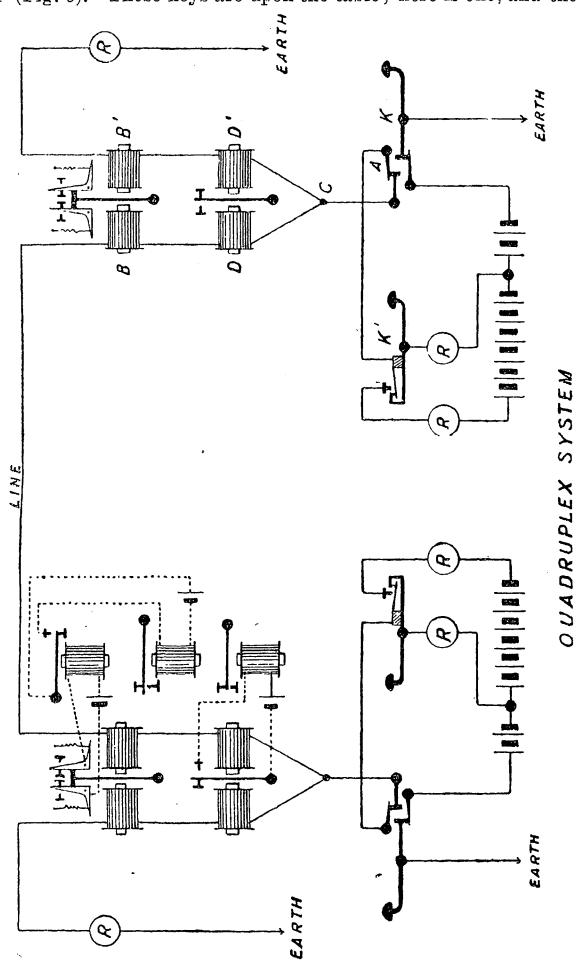
mention it as an illustration of some of the changes that have been attempted in duplex working.

The next system that I told you of was "diplex." Duplex, as you see, is working in opposite directions at the same time. Diplex working means working in the same direction at the same time; but, as this is part and parcel of the quadruplex working, I must speak of it at the time that I speak of quadruplex working.

You see on the diagram that, in duplex working, we are able to compensate the effect of our outgoing currents, and it does not matter one straw what the strength of these outgoing currents may be. Suppose I send a current through these coils from one cell, I have neutrality and no effect; if I send a current from 100 cells, I still have neutrality and no effect. On the other hand, if I send a current from Birmingham to London, say from one cell, I get a very weak effect. If I send it from 100 cells I get a very strong effect. In this diplex system of working, we send two systems of currents from one station to the other. To explain that to you I must refer you to this diagram. I mentioned that we can either vary the direction in which the current goes, or we can vary its strength. The secret of quadruplex working is this—that we have one relay which works with a change in the direction, and we have another relay which works with a change of strength. The currents that work the former relay are weak, those that work the latter relay are strong. Any reversal in a current, whether it be a weak one or strong one, will work the former relay; any change in the strength of the current, whether it be in one direction or the other, will work the latter relay. So that if we send a weak current from the distant station, and change the direction, we work the former relay, and if we send a current in whatever direction, and alter its strength, we work the latter relay.

To produce that alteration in direction or strength we have two keys, K and K^1 (Fig. 9). These keys are upon the table; here is one, and there is



the other. You will see that wherever the key, K, is depressed, it alters the direction of the current. Now, let us see how the current flows. Starting from the battery, the current goes along this wire to A, and on to C, where two paths are open to it, one half goes through the coil B, then through coil D, and on to the line; the other half goes through the coils, B^1 and D^1, in the reverse direction, producing neutrality there, and so on to line; thus we do not interfere with our instrument, but we send a zinc current to line, and when the key, K, is depressed, the lever is lifted and pressed against A, the zinc goes to earth through the key, and the copper goes to line. So that when the key is up the zinc goes to line, and when down copper goes to line, and by working the key we are simply sending positive and negative currents to line. The key K^1, on the other hand, whatever be the direction in which the currents go, simply increases the current, as shown in the diagram, from 20 cells up to 80 cells. If it changes it from 20 cells to 80 cells, it increases it four times, so that every time I depress the key K^1, I increase the strength of current going to line four times. Every time I depress the keys, K and K^1, I do not affect my instrument at all, but in the one case, (key K) I send reversals to the out station, and in the other case (key K^1) I send stronger currents. Just transfer yourselves to the other end of the line, and imagine these currents coming in from the other direction. These weak reversals come through D, and work the relay and its tongue and the sounder in connection with it, then pass through B, but being weak currents, although they attract the tongue of D, they do not affect the tongue of B, the springs of which are strong, and oppose the current, preventing it from acting, and therefore, the currents that operate relay D are innocuous on relay B, because they cannot overpower the springs. If, while working this relay, D, the strength of the incoming current be increased four times, then it overpowers the spring of B, causes its tongue to move, and, therefore, makes a mark. So that you see, if I make dots and dashes with my weak currents, relay D works; if I make dots and dashes with my strong currents, or from key K^1, relay B works, and as D works from reversals quite independent of strength, and B works from strength quite independent of reversal, the result is that, when key K works at the distant station, relay D responds, and when key K^1 works relay B responds, and when they both work together they both respond, and the result is you get diplex working; and, as you work this system in connection with duplex, you are able to work two messages in one direction at one time, two messages at the same time in the other direction, and four messages are passing. [The quadruplex arrangement on the table was here set going, and messages passed between the Central Telegraph Station and the lecture-room.] There you have four messages passing at the same time on one wire.

The history of this instrument is interesting. It was conceived as far back as 1855. Stark, of Vienna, seeing the possibility of duplex working, also conceived the possibility of sending two messages in the same direction at the same time, and, therefore, he suggested the possibility of quadruplex working. Again, in 1873, Mr. Oliver Heaviside showed theoretically, in the *Philosophical Magazine*, how it was possible to work quadruplex, and even multiplex. Any number of messages can theoretically be sent at one time; in fact, by this process that you see it is possible by a series of these keys to vary the strength of your current one to seven times, and by so doing you may send as many as seven, eight, or any number of messages at the same time, but practically, although experiments have been made with the sexiplex (which means six messages at the same time), we practically do not want to send more than four, and the four that the quadruplex gives us are quite enough to meet our wants at the present moment. It was Mr. Stearns also, who, in 1874, first took out a patent, and who first practically showed how quadruplex working was possible; but it was in America where it was first brought into actual work by the Western Union Telegraph Company. Mr. Stearns' ideas were taken over to America by Mr. Orton, the president of the Western Union Company, and when he returned to America he put the matter in the hands of Mr. Prescott, the electrician, and Mr. Edison, their scientific adviser, and after two years of very hard work, Mr. Edison succeeded in introducing the principle that I have explained to you, by which one relay is worked by reversals, and the other relay by increasing the strength of the current. But the principal source of success of the working of the quadruplex is due to the invention of a compound relay; to this peculiar relay whereby the strength of the current overcomes a spring, independent of its attraction, and that is the invention of Mr. Gerritt Smith, the assistant electrician to the Western Union Company. Of course, when the quadruplex has been proved to be practicable, other inventors stream into the field, and we hear of "quads" being introduced in India and other places, and doubtless, in time, somebody else will be able to say that "if called upon he will be able to invent a new quad every day." At present the quadruplex has not been applied to any great extent in England. We have only six circuits working. No doubt we should have more if we wanted them, but we do not want them. In America, however, there are no less than sixty-three circuits worked quadruplex in the Western Union Company's service, and being anxious to have authentic information, I telegraphed on Saturday to Mr. Prescott to let me know how many circuits they had at work, and I received a reply from him this morning, in which he says that "We have sixty-three quad circuits working, and send eight million messages per annum over them. Our New York and Chicago quad averages 1,200 messages per day, from eight a.m. to six p.m." But that is not a very astonishing amount of work. There are many circuits in this country worked by other apparatus (that I shall have the pleasure of showing you next time) with much greater results. But it speaks well for the quadruplex system that there are so many instances in which it has been introduced.

I have not much more to say, and in a moment we will set this quadruplex circuit going again, so that you may have a close view.

I only want to refer to another system of telegraphy (which I cannot show you in operation), which has been introduced in France and Austria, known as the multiple system of working, by Meyer. By this system four, five, or six messages are sent on the same wire at the same time, but it is not based on a system of neutrality, as in these two systems, but is based on a principle of cutting up time. In a type-printing instrument, such as the Hughes, the type wheel revolves for each letter, and time is consumed by such revolution. Meyer and Baudot, who showed a beautiful apparatus at the French Exhibition this year, introduced a system by which time is cut up into slices as it were, and each slice is apportioned to a given message, and, by distributing the time to different stations, they have shown how it is possible to send four or five messages simultaneously, and have increased the capacity of circuits very much.

Another system, called "harmonic telegraphy," has been introduced, patented by Mr. Cromwell Varley as far back as 1870. Mr. Varley took advantage of the principle of the telephone, and, by sending musical sounds through a wire, and taking advantage of the sympathy between the vibration of one instrument and another, he succeeded in introducing a system by which messages can be picked out by sound, at the same time that the wire was absolutely being utilised in sending Morse signals. This principle has been practically carried out by Elisha Gray in America, and I am in hopes of seeing the apparatus over here, and of having the power of giving it a trial. It is rather curious that it was this system of multiple telegraphy, based on harmonic sounds, that led Professor Bell to the introduction of the telephone, and, by the reverse process, it was the invention of the telephone that led Elisha Gray to the invention of the harmonic telegraph, so that they are both dependent on each other. There is also Mr. La Cour, in Denmark, who has introduced a system of harmonic telegraphy. We have not tried it in England yet, and I have no apparatus to show you, and so can only allude to it in this cursory way.

Next time I shall have the pleasure of bringing before you what I believe to be the most perfect system in the world, that is, the automatic, which is used nightly for the distribution of news all over the United Kingdom.

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Do. "B"	81½,	82	82⅝		81	
Do. "A"	31½,	32	32¼		30⅞	
Brazilian	7⅛,	⅝	7⅝		7 7-16	
Cuba	8¼,	⅜	8½		8⅛	
Do. Ten per Cent. Preference	15½,	16½	16		15⅞	
Direct Spanish	2¼,	¾	—		—	
Do. Ten per Cent. Preference	12,	¼	12¼		12	
Direct United States	10⅛,	⅜	10⅜		10⅛	
Eastern	8½,	⅝	8 11-16		8½	
Do. Six per Cent. Debenture	102,	105	104		104	
Do. Five per Cent. do	101,	104	101¾		101½	
Do. Six per Cent. Preference	11⅞,	12	12⅛		12	
Eastern Extension	8½,	⅝	8 11-16		8½	
Do. Six per Cent. Deb.	106,	109	—		—	
German Union	8¼,	¾	8⅜		7⅝	
Globe Telegraph and Trust	4 15-16,	5 1-16	5⅛		5	
Do. Six per Cent. Preference	11½,	¼	11½		11⅛	
Great Northern	8⅝,	⅞	9		8⅜	
Indo-European	22½,	23½	—		—	
Mediterranean Extension	2⅜,	3½	3		3	
Do. Eight per Cent. Preference	9¾,	10¼	—		—	
Reuter's	10,	11	10		10	
Submarine	232,	237	234¾		233	
West India and Panama	1⅝,	¾	1⅝		1 9-16	
Do. Six per Cent. Preference	7⅜,	⅝	7¾		7 9-16	
Western and Brazilian	5½,	⅜	5 13-16		4⅞	
West. Union Seven per Ct. 1st Mt.	120,	125	—		—	
Do. Six per Cent. Sterling	105,	107	—		—	

TRAFFIC RECEIPTS FOR NOVEMBER, 1879.

Companies.	Nov. 1879.	Nov. 1878.	Increase.	Decrease
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	3,000 estd.	2,609	491	—
Direct Spanish Telegraph Company	1,334	1,002	332	—
Direct United States Telegraph Company	—	—	—	—
Eastern Telegraph Company	46,147	37,170	8,977	—
Eastern Extension Telegraph Company	26,379	25,280	1,099	—
Great Northern Telegraph Company	16,653	—	—	—

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Ages at Entry.	Number of Premiums Paid. Thirty.	Twenty-five	Twenty.	Fifteen.	Ten.	Five.
30	£685 10 0	£549 0 0	£434 10 0	£290 10 0	£175 0 0	£78 10 0
45	841 0 0	678 10 0	533 0 0	353 10 0	211 0 0	93 0 0
60	—	—	787 10 0	517 0 0	310 10 0	137 10 0

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SLIP

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LIGHTNING CONDUCTORS.—Mr. Anderson's promised work on this important subject will be published in a few days by Messrs. Spon.

QUEENSLAND.—This colony finds that post office and telegraphs should work together, hence the departments are being amalgamated.

THE CAVENDISH LABORATORY.—We understand that the chair vacant by the death of Professor Clerk Maxwell has been accepted by Lord Rayleigh.

THE CAPE CABLE.—The expedition to complete this cable is making satisfactory progress, and if all goes well the work will probably be completed in another week.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The directors have declared an interim dividend of 5 per cent. per annum, free of income-tax, for the quarter ended 30th September.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated receipts of this Company for the half-month ended with Nov. 30 were £2,152, against £2,352 in the corresponding period of 1878.

AUSTRALIAN DUPLICATE CABLE.—The Sirjapore-Barjocwarjie section of the duplicate Australian cable was successfully laid on the 9th inst. The remaining section will, it is anticipated, be completed early in January.

CANADIAN TELEGRAPHY.—A stock company has been organised at Winnipeg, under a Dominion charter of 1874, to be known as the Canada Central Telegraph Company, with a capital of 100,000 dollars, to build a telegraph line from Winnipeg to British Columbia.

M. COCHERY.—Despite the sweeping changes imminent in the French Cabinet, M. Cochery, Minister of Posts and Telegraphs, will, we believe, retain his Portfolio, for he is so thoroughly master of his department that it would be extremely difficult to supply his place.

THE TELEPHONE.—Messrs. Bass and Co. have placed the whole of their extensive works in telephonic communication; indeed, it is said that they now possess the most unique and comprehensive telephone department of any firm in England. There are twelve wires (some of them two miles in length), worked on the same principle as the telephone exchanges.

HULL.—The action of the Corporation with regard to the electric light has been sanctioned by a town's meeting held on Monday night, when it was resolved to empower the Corporation to apply to the next Parliament for provisional powers to introduce electric lighting into the town, in consequence of the high price charged by two of the three gas companies.

UNDERGROUND LINES.—One of the advantages of subterranean telegraph lines has been brought out by the recent snow storms on the Continent. In France the aerial lines round Paris broke down, and communication between the capital and provinces was seriously impeded; but in Germany no inconvenience was felt, thanks to her admirable system of earth cables.

EXPORTS.—The value of telegraph wire and telegraph apparatus exported during the eleven months ending November 30, 1879, was £1,481,390, as compared with £726,113 during the corresponding period in 1878. The value of telegraph materiel exported during the month of November was £570,572, against £18,862 in 1878. The large increase in 1879 is indubitably due to the increased activity in "submarine cable" work.

THE TROUBLES OF TELEGRAPHIC MANAGEMENT IN CYPRUS.—"A few days ago," says a correspondent, "a Cypriot young man handed into our Larnaca office a neatly sealed packet of some odoriferous powder, with the request that it might be sent on the telegraph to Limassol, and delivered to the address written upon it. It was a difficult matter to make the man believe that the thing was impossible."

ELECTRIC LIGHT IN LIGHTHOUSES.—Many of our English papers have credited an Austrian magazine, *Mittheilungen aus dem Gebiete des Seewesens*, as the authority for certain statistics relating to the lighthouses in which the electric light is used. Unless we are grievously mistaken, the Austrians derived their information from an English source, viz., the last sessional proceedings of the Institution of Civil Engineers.

POST AND TELEGRAPH RECEIPTS IN GERMANY.—In July and August last the receipts for postage and telegraphs were altogether 20,334,270 marks, or £1,016,713. In September and October they had increased to 22,362,325 marks, or £1,118,116, being two million marks, or £100,000, more than in the previous two months, and about one million marks, or £50,000, than the corresponding period last year. The advance is strongest in the Telegraph Department.

DIRECT UNITED STATES CABLE COMPANY.—The liquidators of the old company give notice that a first and final dividend of 3s. 8d. per share will be payable at the offices of Messrs. Deloitte, Dever, and Co., 4, Lothbury, on 29th December, to those members who were on the register on the 8th August, 1877, and who accepted shares in the Direct United States Cable Company, Limited, incorporated in 1877, in lieu of the shares held by them in the other company.

TURKISH SUPINENESS.—"For the space of one month," says a correspondent, "a long length of the Turkish land line from Larnaca to Nicosia was lying on the ground and across the main road. The diligence and lots of bullock carts were passing over it daily. We informed the Turkish telegraph officials of the fact, and for thanks got a shrug of the shoulders and the remark, 'Oh, never mind, we are working all right. When the wire breaks we will send out a man to put it right.'"

PASSIVITY OF IRON.—Iron, when employed as the positive pole of a nitric acid battery, is not acted upon, or, in physical phrase, is in a "passive" state; and this passivity has been found by M. Louis Varenne to be due to a film of nitric peroxide collecting on the surface of the iron, and protecting it from further chemical action. The gas appears to be evolved from the metal, both in the acid and in vacuo. If a stream of carbonic dioxide, or hydrogen, is passed through the liquid, the solution proceeds apace.

THE TELEPHONE.—Glasgow has now three rival telephone exchange companies—the Scottish Telephonic Exchange Company, the Edison Telephone Company, and the Telephone Company (Bell's). Besides these, Mr. Graham, a telegraph engineer of the city, is prepared to establish private lines. A central telephone station has also been opened at Westminster, London, and communication between the Press gallery and *The Times* office, as well as other newspapers, is, we believe, to be made during the ensuing session.

THE TELEPHONE IN PUBLIC OFFICES.—It is gradually dawning upon the minds of business men that they have a new servant at their command, and from various quarters the

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services of the servant are undergoing examination. At a late meeting of Sheffield guardians, Alderman Stacey suggested that the telephone would be very useful in the new parochial offices. The consideration of the suggestion was deferred as not being of an urgent nature, but we hold that on these subjects light is penetrating into the minds of the masses.

THE ELECTRIC LIGHT AT THORNCLIFFE IRON WORKS.—Messrs. Newton, Chambers and Company have introduced the electric light for the purpose of illuminating their extensive works at Thorncliffe. The light is obtained from a Gramme machine (supplied by the British Electric Light Company), which is driven by an engine by Clayton and Shuttleworth, engineers, Lincoln. The apparatus is fixed near the Drift Colliery, a little below the railway, and the lamp in which the light appears is fixed at a considerable height at the pit top.

SCIENTIFIC KNOWLEDGE OF THE NOVELIST.—Anything to raise a laugh or to waste half an hour seems to be the acme of the ambition of the novelist. The poet belongs to a different order. Shakespeare will be found a rare student of nature, as will Tennyson; but the ordinary hack writer seems to think it needless to be accurate in his statements or true in his science. We have in several of the Christmas numbers noticed tales hanging for interest on electrical phenomena—given *au sérieux* by the author as possibilities, yet really as impossible as to boil a roc's egg for a Christmas breakfast.

THE FATAL TORPEDO EXPLOSION.—At an inquest held at the Royal Naval Hospital, Haslar, on the body of Mr. Southey, killed in the recent torpedo explosion at Fareham Creek, it was proved that the countermine had been fired by an accidental contact of the firing key. The key, instead of being connected to the positive pole of the battery, was connected to the negative pole, the return wire being disconnected, and held in a man's hand. In these circumstances the joining of the main wire to the negative pole of the battery by Gunner M'Donald without waiting for the flag signal rendered the mine liable to be discharged by anything accidentally touching the firing key.

HINTS FROM PARIS.—No doubt many readers have seen a little apparatus of an ingenious kind now shown in tobacconist and other shops. It is an apparatus to obtain a light. It consists of a small battery, with a short piece of platinum in the circuit. Opposite the platinum is a small nozzle, from which a jet of gaseous benzoline is thrown. Between the nozzle and the metal is a small cotton wick. On pressing a trigger the jet of benzoline is turned on, a "shutter" in front of the platinum opened, and the battery contact made. The metal becomes incandescent, the jet catches fire and inflames the wick, which continues to burn with a small flame till blown out. Of course the wick is in a reservoir of oil, like that of any other lamp. Our inquiry elicited the information "from Paris."

ELECTRICITY AND CRIME.—The deplorable attempt on the life of the Czar by means of the Moscow mine is a conspicuous instance of the diabolical uses into which electricity may be pressed. In the deserted premises to which the underground passage from the exploded mine led were found two voltaic batteries, in common deal boxes, painted red. One of these was in an outhouse, and its wires were in communication with the other one, which stood in a corner of one of the upper rooms of the dwelling house. From here the electric wires passed through the floor, and along the subterranean gallery to the mine, where they were connected to a fuse placed amongst the explosive material. The arrangement seems to have been successful, and implies the presence of a skilled person.

THE FALLS OF NIAGARA BY ELECTRIC LIGHT.—The illumination of the grand cascade of Niagara continues to attract crowds of visitors. The fantastic displays of colour obtained are said to surpass the richest pigments of the painter. From the terrace at Prospect Park on a dull night the Falls appear under the rays of a red electric light like an immense and swift-sliding avalanche of purple lava. In a moment, by changing the stained glass in front of the electric lamp, the Falls are made to gleam like silver, and when alternate colours are employed it presents the appearance of a splendid moving rainbow. The foam in the abyss at the foot of the Falls when lit by the electric glow shines out like the phosphorescence of the ocean during a tempestuous night. One of the most rare and striking scenes it is possible to witness is the sudden illumination of Niagara by a flash of night lightning, and with the electric light it will be possible to produce the effect artificially.

THE TELEPHONE IN CYPRUS.—The following extract is from a letter from one of the managers of Cyprus telegraphs:—"I have used the telephone very successfully over our line between Kyrinia and Larnaca, a distance of forty miles. The articulation was perfect. The instruments used were got from Trieste, and cost 10f. each. The astonishment of some of the principal inhabitants of Kyrinia when, with the ordinary Morse, I spoke successively with Nicosia, Famagusta, Larnaca, Limassol, and Papho, was indescribable; but the actual voices coming across the plains and over the rugged mountains all the way from Larnaca, a journey (as Cypriots travel) of a day and a half, produced not altogether wonderment depicted on their faces, but intense seriousness, and I have no doubt they looked upon me as an active agent of the evil one. Had there been a telephone at Papho (120 miles distant) I am quite convinced I could have conversed with equal facility with the officer whose good fortune it is to be stationed at the birthplace of Venus."

THE ELECTRIC LIGHT.—An important extension of the electric light, as supplied from the Charing-cross centre of the Société Générale d'Electricité, took place on Monday evening at the Victoria Station of the Metropolitan District Railway. The system was that of Jablochkoff, the current being supplied by a Gramme machine. Ten lights were thus sustained, at a distance of nearly a mile and a half, the length of wire employed being still greater. The engine was the same that has been at work at Charing-cross for the last twelve months in connection with the electric light on the Thames Embankment, lately supplemented by Waterloo Bridge. This engine is accordingly made to maintain sixty lights in all by means of three Gramme machines. The trial at the Victoria Station last evening was only for a brief period, but it was declared extremely satisfactory by the parties present. A fourth Gramme machine, capable of sustaining twenty lights, has just been erected at the Charing-cross centre, and a trial of eighty lights, worked by the Ransomes, Sims, and Head's twenty horse-power engine, will shortly take place. Jablochkoff's candle is now reckoned by M. Ch. Varey to give a light 5-8ths cheaper than French gas.

THE AUDIPHONE.—The megaphone of Mr. Edison is still one of the dark secrets of Menlo Park, but other inventors have attempted to supply its place and provide a handy apparatus for enabling the deaf to hear. One of these has been designed by M. Paul Bert, the eminent French physiologist, and was recently exhibited to the French Academy,

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but did not prove so successful on show as could have been desired. We understand, however, that its originator is still at work upon it. Meanwhile we hear that Chicago has produced a practicable instrument, consisting of a flat flexible disc of resonant metal (probably the metal of which cornopeans are made), japanned and fitted on a handle, after the manner of a circular fan. By means of a cord it can be curved to any extent, and is held in the desired position by a simple clamp on the hand. It acts as a sound board, and requires to be placed under the upper row of teeth, through which and through the bones of the face sounds are conveyed to the auditory nerve. The instrument is all the more efficient in proportion as the auditory mechanism is perfect or imperfect. It is the invention of Mr. Rhodes, and is made by Messrs. Rhodes and Maclure, of Chicago; but we are glad to observe that Mr. James Samuelson, of Liverpool, is arranging to become agent for it in England.

Formation of Alcohol by Electricity.—The well-known French physicist, Berthelot, has succeeded in forming alcohol from glucose by means of electricity. The experiment was conducted as follows:—A battery of eight Bunsen was connected to an oscillating commutator, so as to give positive and negative currents alternately some twelve or fifteen times a second. These currents were sent to two electrodes tipped with cylinders of spongy platinum. These platinum cylinders were then immersed in acidulated water, and the contacts were so arranged that neither oxygen nor hydrogen were disengaged, the two gases recombining again into water as soon as they were separated. This operation was gone through in order to regulate the apparatus, and after being thus tested the electrodes were plunged into an aqueous solution of glucose, from which a small quantity of alcohol was obtained. It is expected that when certain improvements in the apparatus are made the process will be much more rapid. The foregoing research may lead some to think that genuine "electric whiskey" will soon take the market as a rival to the far-famed Glenlivet. Our readers are aware that there are some eminent *savants* who hold that "electricity is life," and no doubt they will discover the remarkable confirmation of their theory in the fact thus demonstrated by M. Berthelot, that electricity can generate *Eau de Vie*.

Electrical Periodicals.—The importance assumed by electrical science in our day, says *The Times*, is witnessed by the increasing number of serial publications devoted to it. The state of things is greatly changed since M. de la Rive, notwithstanding his talent and resources, was unable to maintain more than four years, at Geneva, his *Archives de l'Electricité*. *The Times* goes on to remark that there are now nine electrical serials, including that recently started in Munich by Professor Carl, devoted to applied electricity. These are—for France, *La Lumière Electrique* (monthly), Count du Moncel's organ, and *L'Electricité* (fortnightly); for Belgium, the *Electrica* (monthly); for Switzerland, the *Journal Telegraphique* (monthly), the organ of the International Convention; in America, the *Journal of the Telegraph* (fortnightly), and the *Operator* (fortnightly). In our own country we have *The Electrician*, published weekly, and the *Telegraphic Journal*, twice a month. Italy possesses its *La Natura*, once termed *L'Electrisista*, and the *Bulletino Telegrafico*, omitted by *The Times*. To these may be added the *Journal of the Society of Telegraph Engineers*, in England; the official *Annales Telegraphique*, appearing bi-monthly, in Paris; the *Journal of the Electrical Society of Chicago*, and the *Journal of the Electrical Society of Melbourne*. With these five official and society journals the number amounts to fourteen. It will be observed that of these *The Electrician* is the only one which has attained to weekly publication.

Telegraph Cable Companies.—Naturally the shareholders would be glad if the Government were to "negotiate the taking over most of the cables," for though the gentleman who now makes the proposal says he wants the Government to make a cheap bargain, and not a dear bargain, yet we all know that when the Government is the buyer the price paid is sure to be in excess of what the shares would fetch in the market. The question is whether the public interest would be served by the Government buying the cables. It may be that whilst the cable companies are exposed to competition they cannot prosper, but assuredly such competition must have the effect of lowering the tariff, and, therefore, cannot be antagonistic to the public interest, however much the pockets of the shareholders may suffer. "Cable Investor" writes:—"The various Governments, by taking over the land lines, admitted the necessity of Government management, and of preventing private enterprise." Private enterprise in inland telegraphy was limited before the Government undertook the business, and inland telegraphy, being within the sovereign jurisdiction, could be made a perpetual Government monopoly; but ocean telegraphy can only become a Government monopoly by an international compact, and no Government would, or indeed could, enter into a compact never to construct a new line of ocean telegraphy from its shores without the assent of other Powers. There are so many theoretical objections and practical difficulties with regard to the Government assuming the ownership of the cables, that we advise no one to buy or to hold cable shares merely on the assumption that they must ere long be bought by the State.—*Capital and Labour.*

Freak of Lightning.—A paper was read, at a late meeting of the Clinical Society, by Dr. G. Wilks of Ashford on a remarkable case of lightning stroke which occurred on June 8th, 1878. A farm labourer was struck by lightning under a willow tree. His companions found the tree partly denuded of its bark, and the man's boots standing at its foot. The man was lying on his back two yards off, and though he was fully clothed previously he was now stark naked, with absolutely nothing on except part of the left arm of his flannel vest. He was conscious, but much burnt, and his leg was badly broken. The field around was strewed with fragments of his clothing, which had been rent from top to bottom, the edges of the tears being teased into fringes. It only showed evidences of fire when it came into contact with metal, such as his watch and waistbelt buckle. The laces in the boots were gone; the left boot was torn and twisted into fantastic shape, but the sole was quite untouched. The right boot was similarly torn, and the sole was rent and burnt. The watch had a hole burnt through the case, and was almost entirely destroyed. The stockings were split down the inner side; but the hat was uninjured. The patient stated that he felt struck violently on the chest and shoulders, became enveloped in a blinding light, and was hurled into the air, coming down on his back "all of a crash," and retaining his senses all the time. The hair of his head was burnt and his body was covered with burns. The exemption of the nervous system from stunning by the shock is the remarkable feature in this case, and was probably due to the clothes diverting the discharge from the great nervous trunk. Another curious lightning stroke happened to a labourer quite recently. It whirled a pitchfork he was carrying out of his hands, and twisted the forks into a pair of corkscrews.

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CONTRIBUTIONS TO A PHYSICAL THEORY OF ELECTRICITY.

BY DESMOND G. FITZGERALD.

(CONTINUED FROM P. 41.)

Work and *Energy* are values of the same nature and dimensions, work being potential energy, and energy potential work. Thus gravity may be said to do work against the resistance (inertia) of a falling mass when work done against the weight of the mass (or gravity) is converted into kinetic energy (energy of motion). Work (W) is measured by fs; where f is the constant or mean force producing motion, and s the *space* (height or distance) *through which this force is applied*. This latter value is very often confounded with the space (S) *through which the body is moved* by the effect of the force f. If ϕ (the Greek letter *phi*) be the resistance against which work is done by f, then ϕ S measures the *energy of position* obtained by the mass moved by f. Then, by the principle of the Conservation of Energy, we have

$$W = fs = \phi S. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (I.)$$

$$\text{Whence } S = s\frac{f}{\phi} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (II.)$$

$$\text{and} \qquad s = S\frac{\phi}{f}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (III.)$$

The reason of the inequality between s and S is that the kinetic energy generated by f, in the time (t) during which it acts, carries the mass through the space S$-s$ in the time t_1-t (t_1 being the time in which the space moves through the space S). The value $t_1=t\frac{f}{\phi}$ is often confounded with t.

In gravitation measure, work and energy of position are often expressed as mh; m being sometimes taken as *mass* and sometimes as *weight*, and h being the height to which the mass is raised. It is evident that this expression is inaccurate if m be mass; and, on the other hand, the ordinary expression for kinetic energy (equation e), derived from the expression for work, becomes inaccurate if m be taken to express weight. Here unit work is the raising of unit mass through unit length against the force (g=32·19) with which gravity acts on unit mass. On the foot-pound-second absolute system, this work would be expressed as gs=16·095. We have then, in gravitation measure,

$$W = m\,h \text{ foot-pounds}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (a)$$

But $\frac{\text{accelerating force}}{\text{mass}}$, or *acceleration*, is measured by velocity produced, *in any mass*, in unit time, and is expressed as

$$f = \frac{v}{t}. \text{ units of acceleration per second.} \quad . \quad . \quad (b)$$

When work is converted into kinetic energy by the fall of the mass under the uniform acceleration of gravity, the space (h) fallen through will evidently equal the *mean* velocity (which is half the final velocity, or $\frac{v}{2}$) multiplied into the time during which the mass has moved with this mean velocity, or

$$h = \frac{v}{2}t \text{ . feet.} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (c)$$

From equation (b), the time in which a mass moves through a given space is

$$t = \frac{v}{f} \text{ seconds.} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (d)$$

Substituting this value for t in equation (c),

$$s = \frac{v}{2} \times \frac{v}{f} = \frac{v^2}{2f} \text{ . feet.} \quad . \quad . \quad . \quad . \quad . \quad (c_1)$$

Consequently,

$$m\,h = m\frac{v^2}{2f} \text{ foot-pounds.} \quad . \quad . \quad . \quad . \quad (e)$$

or, since $2f = 2g = 64{\cdot}38$, $m\,h = m\frac{v^2}{64{\cdot}38}$ *foot-pounds*, an equation which shows the equivalence between work, or energy of position, and kinetic energy, and which is most useful in calculating the energy stored up in moving bodies, such as a cannon-shot or a railway truck. In the equation $m\frac{v^2}{2f}$ for kinetic energy, m necessarily signifies mass: the *weight* of the mass does not at all affect the value. In this system (gravitation measure) the equation (e) is therefore, as pointed out above, necessarily inaccurate.

In any of the ordinary absolute systems, the equivalence between work and kinetic energy may be *correctly* demonstrated, as follows:—

$$W = fs = \phi S.$$

But $\phi = m\,a$; m being *mass*, and (a) *acceleration*. Thus, in the case of gravity, $\phi = m\,g$.

$$\text{Therefore} \qquad W = m\,S\,a. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (IV.)$$

Acceleration is defined as

$$a = \frac{v}{t}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (V.)$$

t being here the time in which the velocity v is obtained.

In the case of uniformly accelerated motion, we have, necessarily,

$$S = \frac{v}{2}t. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (VI.)$$

By (V.),

$$t = \frac{v}{a}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (VII.)$$

Substituting this value of t in equation (VI.),

$$S = \frac{v^2}{2a}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (VIa.)$$

$$\text{Therefore} \qquad fs = \phi S = m\,a\,\frac{v^2}{2a} = m\frac{v^2}{2}; \quad . \quad . \quad . \quad (VIII.)$$

the last value being the expression for kinetic energy in absolute units (of work or energy) based upon any given fundamental units of length, mass, and time.

According to the absolute system I have generally adopted in my own work [see Appendix I.], the expression for kinetic energy is

$$m\left(\frac{v}{2}\right)^2 = m\frac{v^2}{4}.$$

That branch of dynamics which treats of forces producing *uniform motion* is undoubtedly the one which is directly of greatest interest to the electrician, as well as to the engineer, and, indeed, to all who are engaged in the applications of physical science. In such applications, accelerated motion, and especially uniformly accelerated motion, is comparatively seldom illustrated, and practically seems to be of only secondary importance. Thus, the molecular motion involved in the passage of a constant current of electricity, like the motion of mass produced by a steam engine, may be generally considered as being uniform—as being accelerated and retarded only for a brief period, when it commences and when it ceases. In this kind of motion—the consideration of which, from a dynamical point of view, seems to me to have been much neglected—the resistance (ϕ) opposing motion becomes, when a certain velocity has been obtained, equal to the force (f) producing motion. I shall endeavour—though with very imperfect means for mathematical treatment—to approach the questions connected with uniform motion and uniform work through the consideration of uniformly-accelerated resisted motion, when work is done with a comparatively low value of the ratio $\frac{f}{\phi}$. But, in the first place, I am called upon to give a definition or a fixed meaning to some dynamical values other than force, work, and energy.

What is correctly called *Power*—an expression generally limited to the case of uniform motion—is the ratio $\frac{\text{Work}}{\text{time}}$. Thus, in engineering, horse-power $= \frac{\text{foot-pounds} \times 33{,}000}{\text{time in minutes}}$. The term is useful to indicate the work that can be done in a given time by a prime mover, and thus to afford an expression of its relative value. It has, however, been more abused than any other dynamical term, with the exception, perhaps, of the word "force." Thus a lever, a pulley, or a screw is often referred to as a mechanical "power;" the force *(f)* applied to any such simple machine to overcome the resistance or weight (ϕ) is also called the "power;" and the force of steam or water is termed "steam power" or "water power." Faraday calls gravity, heat, electricity and magnetism "powers" or "forms of force," referring particularly to gravity as "a case of power;" and we are sometimes puzzled to guess what can possibly be meant by such expressions as "power" of a battery or other electromotor. In the ordinary systems of absolute measurement, *power* would be expressed by $f^2\,\frac{t}{2} = f\frac{v}{2} = m\frac{v^2}{2t}$.

(TO BE CONTINUED.)

ERRATUM, page 41, Appendix I.—In the heading of third column ft^2 should be $\frac{ft^2}{m}$; and in the heading to fourth column $\frac{W}{m}$ should be W.

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CANTOR LECTURES.*

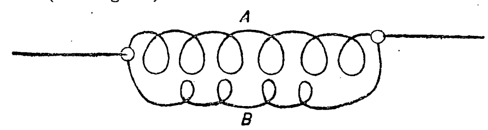
RECENT ADVANCES IN TELEGRAPHY.

By W. H. Preece, Electrician to the General Post Office.

Lecture V.—Delivered May 19.

AUTOMATIC TELEGRAPHY.

In all the different forms of telegraphic apparatus hitherto brought before you, we have been dependent upon the operation of a key controlled by the hand, the key being raised and depressed to produce dots and dashes, in the case of the Morse alphabet; or beats, representing the alphabet, on the dial instrument. This process of keying, of course, necessitates a considerable amount of skill on the part of the operator. It requires great practice to send these dots and dashes with regularity, so as to avoid errors; and the constant manipulation of the key also involves a considerable amount of endurance on the part of the operator. Hence, the operation of keying results in fatigue; a clerk goes to his instrument in the morning fresh, but after a few hours working, loses his strength, tires, and becomes slower in carrying out the operation; and perhaps gets, towards the end of the day, a little careless and indifferent, thus causing errors to arise. The maximum rate at which a clerk works is dependent upon the combination of strength and practice; and although operators have been known who could transmit the Morse alphabet at the rate of forty-five words a minute, forty is a very high speed, and thirty-five is about the average of the most experienced operators. While thirty-five, say, is the average rate at which a key can be worked, the receiving part of the apparatus, that which records the dots and dashes on paper, or that which registers the dots and dashes by sound, has a very much higher capacity. The capacity of an instrument is, as I will show you, practically almost unlimited. The rate at which instruments are worked is, no doubt, limited by the rate at which a clerk can write; but it very early struck telegraphists that if it were possible to replace by mechanism the terribly slow rate of manipulation by hand, it would be possible to reach the maximum rate of recording on an instrument, and thereby expedite the operation of telegraphy. Mechanism excels manipulation in several points. The transmission of currents by mechanism ensures precision in properly marking off the dots and dashes, or the signals representing dots and dashes. It secures precision in the form of spaces, and these, after all, are the principal element in the Morse alphabet. The precision leads to accuracy, and accuracy in transmission is a great essential in carrying out telegraphy. Practically, mechanism can be made to receive as fast as may be, and if it were only possible to secure a machine to send in place of the hand, the means are produced of enormously increasing the speed at which it is possible to telegraph. In receiving messages by mechanism at high speed, of course you exceed the rate at which a clerk can write, but you are able to divide your labour, and as the message rolls out on the Morse tape, you can cut it up into pieces, and hand the pieces round to different writers, to write out the messages received. Another great advantage in the use of apparatus worked by mechanism and at high speed is that it prevents the possibility of wires being "tapped." We know that during the American war it was a common practice to "tap" the wires, and receive information of operations going on; and, again, one of the most serious objections recently brought against the introduction of telephone has been the facility with which it can be used to tap wires; but where wires are worked by mechanism and by automatic apparatus, the possibility of tapping entirely ceases. It is a very curious fact that the very first form of the telegraph introduced by Morse in America, in the year 1844, was one in which automatic apparatus was used to transmit dots and dashes. A type upon which the dots and dashes were cut was set up in sticks, and these sticks passed through an instrument, and the dots and dashes were actually transmitted by mechanism. But it was not until 1846 that automatic telegraphy really took a practical form, and in that year Alexander Bain, a great genius in his way, conceived the idea of punching this alphabet of dots and dashes on paper, which punched paper passes beneath a brush or style, and so replaced the keys. This receiver was one of a different kind to any I have shown you. It was dependent upon the action of the current on a chemical compound. When a current, for instance, passes through water, it decomposes the water into its constituent elements, oxygen and hydrogen. When it passes through sulphate of soda, it decomposes that sulphate of soda into sulphuric acid and sodium; or when a current passes through a solution of iodide of potassium, it decomposes the solution into its two constituents, iodine and potassium. I have here one of Bain's original form of receivers, and I will show you directly how the dots and dashes are produced by the decomposition of iodide of potassium. The dots and dashes, as they are sent by the transmitter, are received upon a slip of paper that has been saturated with iodide of potassium, and the signals are produced by the chemical action of the current on this paper. Here you see the puncher used to punch the dots and dashes; here is the transmitter which mechanically transmits the dots and dashes, and here is the beautiful receiver which chemically records the signals. But, practically, the Bain instrument was before its time. The speed attained on it was enormous. Lardner, in one of his books, details an experiment where from 1,000 to 1,100 words were recorded in a minute. But this was only on "short circuit," and only an experiment in a room. When the instrument was applied to a land wire, and became subject to all the disturbances that line wires are liable to—disturbances arising from insulation, or variations of the atmosphere and other causes—then the instrument began to be troublesome, and because it was not wanted it was allowed to drop out of use. It was not wanted, for the simple reason that the business in those days was not sufficiently large to necessitate automatic or fast speed telegraphy. The system of Bain was introduced in America in 1849-50, and it had a good run there, because it was started in opposition to the Morse apparatus. It has, within the last three or four years, again been resuscitated in America, because about four years ago active competition led to a reduction of rates, and this produced a considerable accession to business, which was a good opportunity for the reintroduction of Bain's instrument. The effects of disturbances, such as were experienced in 1846-50 on an actual trial of Bain's instrument in England (between London and Southampton), were removed in America by an Englishman of the name of Little (who had domiciled himself in the New World), by applying an electrostatic "shunt" or condenser to the receiving apparatus. And that prolific inventor that we hear so much about, Edison, also still further improved the instrument by substituting for the electrostatic shunt an electro-magnetic shunt. A shunt, I must tell you, is merely a technical term applied to a wire or an electro-magnet that abstracts a certain amount of a current. (See Fig. 10).



If the spiral A represent a wire, or magnet, and another spiral, B, representing another wire or magnet, were inserted so, this would be the shunt, or electro-magnet. Shunts are very frequently used in telegraphy for various purposes.

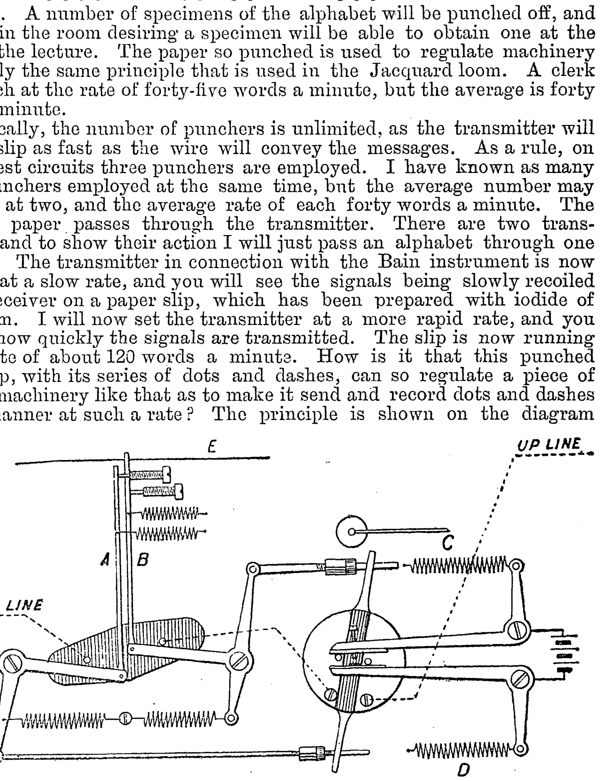
Siemens and Halske also introduced in 1853 an automatic system in Germany, and they have improved their system since then so much that, in 1876, it was used along the Indo-European line between London and Teheran. In 1858 another of our most brilliant geniuses in this country devoted his attention to automatic telegraphy, and that was Professor Wheatstone. From 1858 to 1862 Professor Wheatstone continued to devote his attention to this system of automatic telegraphy, and, with the aid of the mechanical power and genius of Mr. Stroh, he succeeded in producing a thoroughly practical system, and this system (the Wheatstone automatic) was adopted by the Electric Telegraph Company of this country. The Wheatstone automatic apparatus consists of three parts—the perforator, the transmitter, and the receiver. The Wheatstone system differs from all others in the punching of its characters. On the table there is a puncher, and I will just ask Mr. Cooper to punch an alphabet, so that you may see what the operation of punching really is. [Mr. Cooper punches a slip.] The puncher is a little apparatus, consisting of three pistons, which are capable of being depressed.

Here is a specimen of punched slip :—

o o o o o o o o o o o o o o o o o
o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o
o o o o o o o o o o o o o o o o o o

The centre one of these three pistons, on being depressed, punches the succession o o o o o o of holes in the centre of the specimen; the left-hand
o o o o o o
piston punches the holes, simultaneously, opposite each other, o o o o o o,
o o o o o o
as well as the centre; and the right-hand piston punches the holes, simul-
o o o o o
taneously, in a diagonal position, o o o o o . The two holes (o/o) opposite
o o o o o
each other represent a dot, the diagonal ones (o ˌo) a dash, and the centre holes are for the purpose of propelling the slip forward. A is represented by
o o o o o o o o o o o o o
o o o, B by o o o o o, C by o o o o o o, D by o o o o, and so on through the
o o o o o o o o o o o o o
alphabet. A number of specimens of the alphabet will be punched off, and any one in the room desiring a specimen will be able to obtain one at the close of the lecture. The paper so punched is used to regulate machinery on exactly the same principle that is used in the Jacquard loom. A clerk can punch at the rate of forty-five words a minute, but the average is forty words a minute.

Practically, the number of punchers is unlimited, as the transmitter will run the slip as fast as the wire will convey the messages. As a rule, on the busiest circuits three punchers are employed. I have known as many as six punchers employed at the same time, but the average number may be taken at two, and the average rate of each forty words a minute. The punched paper passes through the transmitter. There are two transmitters, and to show their action I will just pass an alphabet through one of them. The transmitter in connection with the Bain instrument is now running at a slow rate, and you will see the signals being slowly recoiled by the receiver on a paper slip, which has been prepared with iodide of potassium. I will now set the transmitter at a more rapid rate, and you will see how quickly the signals are transmitted. The slip is now running at the rate of about 120 words a minute. How is it that this punched paper slip, with its series of dots and dashes, can so regulate a piece of delicate machinery like that as to make it send and record dots and dashes in this manner at such a rate? The principle is shown on the diagram



WHEATSTONE'S AUTOMATIC SYSTEM

(Fig. 11). I have before mentioned how extremely difficult it is to render diagrams of intricate apparatus comprehensible to an audience. It is always better for any one who wishes to understand how an apparatus works to examine it himself, to make himself acquainted with its principle, and examine the actual mechanism itself.

(TO BE CONTINUED

* From the *Journal of the Society of Arts* for November, 1879.

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THE SOCIETY OF TELEGRAPH ENGINEERS.

To an orthodox electrician, the last meeting for the session of the Society of Telegraph Engineers is a scientific reminder of the proximity of Christmas and the close of the year. In this respect, at least, it may be said to bear some resemblance to those apparitions of plucked geese and smiling evergreens which adorn our shop windows at this festive time. Christmas, indeed, comes but once a year, and when it comes it is invariably preceded by the annual general meeting of our Society. We do not pretend to know whether this is the result of a deep laid scheme on the part of the promoters of the Society or not; but it is certain that they could hardly have chosen a better period for the favourable reception of balance sheets and the bland approval of new projects. At such a time, a general feeling of benevolence pervades the breast, and disposes even the most captious critic to look leniently on the secretarial report for the past year.

It was not solely due to this spirit of good will, however, that the annual report of the Society of Telegraph Engineers was well received by the members and associates assembled on December 10. There were communications in the document itself which made it more than usually satisfactory. Like most young institutions and individuals, the Society has passed through its weak and languishing phases; it has suffered from internal dissension, from morbid cliquism, and from indigence; but we are happy to observe that it begins to show signs of a healthier condition. It now comprises 1,019 members, a number amply sufficient to make any society flourish; but, unfortunately, many subscriptions are in arrear, a state of things which is largely due to the abundance of members resident abroad. Still, the facilities for transmitting money are copious, and foreign residence can hardly be pleaded as an excuse for neglect of payment. It would be well, perhaps, if the rule of exclusion from the Society in case of non-payment were strictly enforced. That the finances of the Society are improving is testified by the announcement that one-third of the loan for printing purposes has been paid off. The surplus funds arising from the sum so liberally subscribed by certain members for the entertainment of the International Delegates last summer has been wisely applied to the completion of the Ronalds Catalogue and the binding of the Ronalds Library. The preparation of this catalogue, which is really a list of all the works, whether home or foreign, on electricity published up till the time of the death of Sir Francis Ronalds, has been an arduous task for Mr. A. J. Frost, the librarian of the Society, and he has performed it with laudable zeal, care, and neatness. The Ronalds Library comprises some 10,000 works, including pamphlets, and the books are being elegantly bound in morocco of different dyes. It is expected that the books will be bound and the catalogue printed by the end of next March.

One condition of the Ronalds trust was to the effect that the Society should become incorporated by Royal Charter, and it is welcome intelligence to hear that steps will be taken during the ensuing session to obtain this dignity. Such a charter cannot fail to benefit the Society in more ways than one; and another good prospect is the share which the Society will have in the munificent endowment which Dr. Siemens has made for the furtherance of applied science.

The recent fresh developments of electrical science, which were marked by the invention of the telephone and microphone, and the revival of the electric light, have opened the eyes of electricians to the extended practice, and the still wider possibilities of their profession; and there is great justice in the steps taken by Mr. Latimer Clark, with a view to getting the scope and title of the Society altered to suit the times, and embrace within its pale the multifarious applications of electricity which now exist. A fitting title would, we think, be the "Society of Electricians and Telegraph Engineers," and doubtless the change will be effected at the time of the incorporation by Royal Charter. These two events occurring simultaneously would serve, as it were, to signalise the "coming of age" of the Society.

The appointment of Mr. W. H. Preece to the presidential chair in the room of the retiring president, Lieut.-Colonel Bateman-Champain, R.E., and the election of Prof. Hughes, Mr. C. F. Varley, and Mr. Stroh to the Council, are events on which we must also congratulate the Society. It is the custom nowadays to describe a man who is well adapted to a

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particular duty as being "born" to it, so that we are under an obligation to the higher powers not only for our seers and poets, but for our lawyers, editors, and pedagogues, not to speak of the obscurer geniuses who were created to concoct new soups and fashions. If we were to fall in with this custom, we should say that Mr. Preece is a "born chairman;" and we feel sure that, by his animating example, good humour, abundant energies, and social instincts, he will lure the members of the Society from their reserve, and stimulate the meetings into liveliness and geniality.

Thus far we have been considering the past and present state of the Society; but at an important time in its career like the present, we are tempted to look into the future, and try to cast its horoscope. Dim visions present themselves of a time when it shall be a great and flourishing body, with its honours, titles, prizes, libraries, and museums, the centre of electric science throughout the world. But in picturing the unheard-of and marvellous applications of electricity which will yet be made, the imagination would only be beguiled. No one can tell what mighty and magical things it will yet accomplish; but we are tolerably certain that the curious electrician of the remote future, in tracing back the archives of our Society to the present time, will be filled with amazement to see how much we have achieved by means of an agency of whose real nature we knew nothing.

EXPERIMENTAL RESEARCHES ON THE ELECTRIC DISCHARGE WITH THE CHLORIDE OF SILVER BATTERY.

By Warren De La Rue, M.A., D.C.L., F.R.S., and Hugo W. Muller, Ph.D., F.R.S.

(concluded from page 44.)

With the data already published in Part I. the authors have laid down a fresh curve for the striking distance between flat discs on a scale of 10 centims. for a millimetre and 5 centims. to 1,000 cells.

From the curve thus laid down the following numbers were deduced:—

E.M.F. in volts.	Striking Distance in Centimetres.	Difference of Potential per Centimetre.	Intensity of Force.	
			Electro-magnetic.	Electro-static.
		Volts.		
1,000	0·0205	48,770	$4·88 \times 10^{12}$	163
2,000	0·0430	46,500	4·65 ,,	155
3,000	0·0660	45,450	4·55 ,,	152
4,000	0·0914	43,770	4·38 ,,	146
5,000	0·1176	42,510	4·25 ,,	142
6,000	0·1473	40,740	4·07 ,,	136
7,000	0·1800	38,890	3·89 ,,	130
8,000	0·2146	37,280	3·73 ,,	124
9,000	0·2495	36,070	3·61 ,,	120
10,000	0·2863	34,920	3·49 ,,	116
11,000	0·3245	33,900	3·39 ,,	113
11,309	0·3378	33,460	3·35 ,,	112

The remainder of the Paper is chiefly occupied with the study of the phenomena of the electric arc under various conditions of distance, pressure, and potential. The results obtained support the view that the arc and the stratified discharge are merely modifications of the same phenomenon.

The experiments were made in a bell-jar, containing the terminals, which could be gradually exhausted after having been filled with air or other gas. One of the terminals was fixed to the bottom plate, the other could be adjusted to any distance from it by a rod sliding through a stuffing-box in the glass cover. The foot of the stand was insulated by a disc of ebonite, on which it stands. One such bell-jar is 9¼ inches (23·4 centims.) high and 5⅞ inches (14·9 centims.) in diameter; its cubical content, obtained by covering the open ends with glass plates and filling with water from a graduated measure, was found to be 3,787 cub. centims.

A remarkable phenomenon was observed on making connection between the terminals and the battery by means of the discharging key (already described in Part I.), namely, that within certain limits of pressure in the bell-jar a sudden expansion of the gas took place, and that as soon as the connection was broken the gas then as suddenly returned nearly, but not quite, to its original volume in consequence of a slight increase of temperature. The effect was exactly like that which would have been produced if an empty bladder had been suspended between the terminals, and suddenly inflated and as suddenly emptied.

The following experiment in rarefied air, at a pressure of 56 mm., at a temperature of 17·5°C., will give an idea of the the amount of instantaneous expansion which occurs when the terminals are connected with the poles of the battery of 11,000 cells, current 0·01102 W; the resistance of the bell-jar was reproduced by substituting 600,000 ohms wire resistance:—

	mm.	M.
Distance of the terminals—the top one a point, the lower a disc—6 inches; pressure	56	73,684
On making contact the arc passed and the column of mercury was depressed	15·8	20,789
Pressure on connection ...	71·8	= 94,473

The increase was to the normal pressure in the ratio of 1·282 to 1; as the gas was kept at a constant volume, and supposing the expansion to be due to an increase of temperature, the pressure would vary as the absolute temperature,* therefore $\frac{T'}{T} = \frac{71·8}{56} = 1·282$, whence $T' = 1·282 \times 291·2 = 373·3°$ C.; $(373·3 - 273·7) = 99·6$°C., the temperature of the bell-jar, and $(99·6 - 17·5) = 82·1°$, the rise of temperature while the discharge was taking place. But the temperature of the bell-jar, as determined by a thermometer enclosed in it with its bulb uppermost, only rose 0·64°C. per second, taking into account the rate of cooling. It is evident, therefore, that the increase of pressure cannot be ascribed to the instantaneous heating of the bell-jar 82°C.

Taking the dimensions of the arc from a photograph, it was calculated that it must have attained the enormous temperature of 16,114°C., if the increase of pressure was really due to heat. It was found that platinum wires 0·001 inch in diameter supported in various parts of the arc were immediately fused; the temperature of the arc was therefore as high as the fusion-point of platinum, and possibly considerably higher.

If the whole of the heat evolved by a current of 0·01102 W, through a resistance of 600,000 ohms had been communicated to the air in the jar, weighing 0·339 grm. it would raise it 215·6°C., in one second. It is known from direct experiment that this enormous evolution of heat was not communicated to any extent to the air in the bell-jar, because its temperature only increased about 0·64°C. per second; the heat must consequently have escaped almost instantaneously by radiation. It is difficult consequently to realise the conjecture that the enormous dilatation which occurred instantaneously could have been caused by increase of temperature. And it points to its being produced by a projection of the molecules by electrification causing them to press outwards against the walls of the containing vessel, this pressure being distinct from the motion caused by heat.

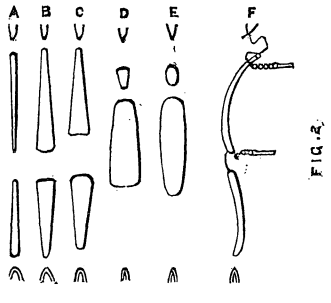

FIG. 2.

The authors proceed to describe the appearance of the arc with terminals of various forms at different distances and with various pressures. It was found that the light emitted by different parts of the arc was not of the same intensity throughout, and that from the first there was a tendency to break up into distinct entities, as shown in the diagram, Fig. 2, which only indicates the central bright portion of the arc. This never quite reached the negative terminal, near which there was always the well-known dark discharge.

* Absolute zero = 273·7 C., 273·7 + 17·5 = 291·2.

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As the pressure was diminished the arc widened out until at last the entire surface of the negative disc was covered with a luminous halo, and the discharge took up a stratified appearance.

The appearances presented by the arc in air, hydrogen, and carbonic acid are copiously illustrated by copies, in mezzotint, of photographs and drawings as in Part II. in the case of stratified discharges in tubes. During the course of these observations the increased pressure caused by the current was recorded, and an arrangement was made to ascertain whether the increase of pressure was greater near one or the other terminal. For this purpose a divided bell-jar was constructed, both ends of the two halves being accurately ground, and a glass disc divided the chamber into two parts; in this there is a hole half an inch in diameter made with a raised rim, in order that plates of mica with holes of different diameters might be cemented with Canada balsam centrally to the diaphragm. The capacity of the upper half was found to be 1,530 cub. centims., that of the lower half 1,755, total 3,285.

That portion of the chamber which was in communication with the gauge was connected alternately with the positive or negative terminal of the battery, and the depression noted. When this chamber was either — or + the ratio of increase to the normal pressure was:

—	+
1·44	1·39
1·34	1·41
1·13	1·20
1·22	1·34
1·38	1·40
1·16	1·11
1·19	1·16
1·266	1·287

It would appear, therefore, that the dilatation of the gas is the same both in the positive and negative chambers.

In order to prosecute their experiments in a vessel of still greater capacity the authors had constructed a larger jar with a neck at each end, or, more properly speaking, perhaps, a tube supported horizontally on ebonite crutches. It is 37 inches long and $5\frac{13}{16}$ inches in diameter. Its cubical content was found to be 14,435 cub. centims., or 3·8 times that of the bell-jar employed in the experiments on the electric arc.

The experiments with this tube will necessarily occupy a considerable period, partly on account of the long time it takes to exhaust it after each set, partly on account of the variety of experiments it is intended to make with it; consequently they describe only a few of the first results hitherto obtained.

For Example in Air.

Pressure 3 mm., 3,947 M, 6,300 cells. Two luminosities were formed, the ring negative being surrounded with a nebulosity which completely filled the end of the tube. The tube glowed brilliantly with a blue fluorescent light, which proved to have great actinic power. A dry-plate photograph obtained in five seconds records a very curious phenomenon, namely, that the outer boundary of the luminosity appears *darker* than the tube. It is to be remarked that while the discharge was reddish (nitrogen), the fluorescence of the tube was blue; the effect appears to be due to the absorption of a portion of the fluorescent light emanating from the back of the tube in passing through the red luminosity. The effect was quite unexpected, and it was thought at first that it might have arisen from some peculiarity in the development of the dry plate; it was not therefore until the result had been confirmed by other photographs that they ventured on the explanation above given.

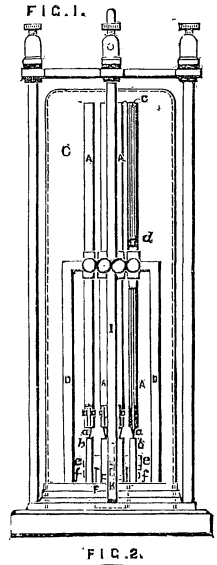
The paper closes with the following conclusions:—

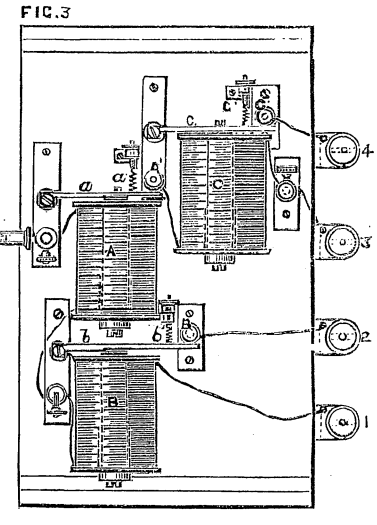
1. *For all gases there is a minimum pressure which offers the least resistance to the passage of an electric discharge. After the minimum has been reached, the resistance to a discharge rapidly increases as the pressure of the medium decreases.* With hydrogen the minimum is 0·64 mm., 842 M; at 0·002 mm., 3 M, it is as great as at 35 mm., 46,000 M.
2. *There is neither condensation nor dilatation of a gaseous medium in contiguity with charged terminals.*
3. *When the discharge takes place there is a sudden dilatation of the medium in addition to and distinct from that caused by heat. This dilatation ceases instantaneously when the discharge ceases.*
4. *The potential necessary to produce a discharge between parallel flat surfaces at a constant distance and various pressures, or at a constant pressure and various distances, may be represented by hyberbolic curves. The resistance of the discharge between parallel flat surfaces being as the number of molecules intervening between them.*
5. *This law does not hold with regard to points. In Part I. it has been shown that the potential necessary to produce a discharge at the atmospheric pressure and various distances is as the square root of the distances, while the potential necessary to produce a discharge between points at a constant distance and various pressures is in the ratio of the diminution of the pressures divided by a factor.*
6. *The electric arc and the stratified discharge in vacuum tubes are modifications of the same phenomenon.*

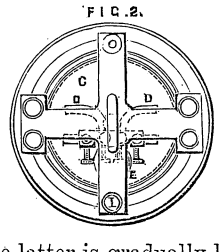
Lastly, the authors say:—"We have again pleasure in thanking Professor Stokes for his much-valued advice during the course of our investigations. To our assistant, Mr. Fram, we are indebted for his able co-operation; and we have to thank Mr. H. Reynolds for his aid and skill in taking photographs."

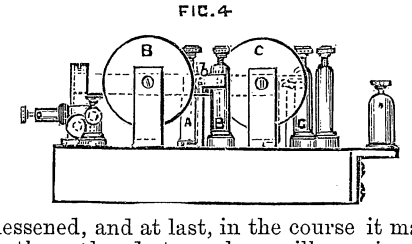
ANDRE'S ELECTRIC LAMPS.

The inventor wishes to construct electric lamps suitable for lighting mines. He therefore arranges to employ a series of thin carbon rods, which rest on a larger piece of carbon or metal, or on a corresponding number of pieces of carbon or metal, or a solid carbon cylinder encased in metal. Fig. 1 is a front elevation, and Fig. 2 a plan of the arrangement as constructed especially for use in mines. *a*, *a*, *a*, *a*, are four carbon rods, and *b*, *b*, *b*, *b*, four copper discs, or instead of four copper discs a copper cylinder may be used, long enough for all four carbon rods to rest thereon. The carbon rods *a* are enclosed in tubes A to slide easily therein, and are lightly pressed down by small loose weights *c* resting on them. *d* is an intervening button or guide-piece, in which the upper end of the carbon is inserted. By means of a commutator (see below) one of the carbons *a* only is kept in a state of incandescence at a time, and when that one from some cause is rendered inoperative, the next carbon is automatically rendered operative or incandescent. To prevent waste of the carbons, and as regards mines also to prevent fire-damp explosions, the carbon rods *a* and the parts are enclosed in a glass cylinder C. As the oxygen therein is consumed by the combustion of the carbon, the rate of wasting of









the latter is gradually lessened, and at last, in the course it may be of, say, half an hour, the enclosed atmosphere will consist of nitrogen and carbonic acid only, and the further waste of carbon becomes very slow. The discs *b* are by a central bar *e* connected together, and the two outer discs *b* are by screws *f* pivotted excentrically to the bracket or carriage F. The negative pole is by the bracket F connected to the discs *b*, as shown, or the large piece of carbon or metal and the positive poles to the carbon rods. The enclosing tubes A are connected to the positive pole through the standards D, and have each at the lower end a lever *g*, the outer and heavier end of which serves to press the carbon against the lower part of the tube A. The part of the lever coming against the carbon is hollowed out so as to partly embrace it, and thus produce good electrical contact and causing the current to enter the carbon from both sides. The carbon, in gradually burning or wasting away, leaves a silicious deposit on the metal disc or other part on which it rests. This deposit causes occasional sudden extinction of the light by interrupting the current; another cause of extinction is the softening to a pasty consistency of the lower part of the carbon, causing

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this part to adhere to the tube at the place of contact therewith. To obviate both these evils a turning action is imparted to the disc *b* in the following manner:—E is an electro-magnetic core with coils round it connected to the bracket F and one of the outer rods, viz., the one for the return current. The keeper or armature G of this electro-magnet is fixed to the central bar *c* of the discs *b*; H is a stopper for preventing the armature G from receding too far from the core E; K is a stopper on the opposite side for preventing the armature from approaching too near to the electro-magnet, and which may, as here shown, be provided with a coil, also connected to the rod I for the current return, but shorter than the coil on the core E; thus producing less resistance to the current and causing a small part of the current only to act on the electro-magnet after the armature has been attracted. When the current passes through the coils of the electro-magnet the armature is attracted, and the carbons are thereby pulled over into good contact with the lower ends of the tubes. The larger portion of the current is shunted through the stop K to the terminal rod I in order to lessen the attractive force of the electro-magnet and to diminish the resistance. In case the current be interrupted at the place of incandescence the armature G is let go from the position shown, and a spring *h* then turns the excentrically-mounted discs slightly in the direction of the arrow, thus causing the disc to rise a little, whereby the carbon if stuck will be released, and whereby also any silicious deposit on the discs will be pushed away by the carbon point. When the circuit has thus been restored the armature will be attracted again and the discs thereby be turned into their former position. In another arrangement M. André inclines one or more positive carbon rods against a larger central negative carbon rod or slab, so that the outer ends of the former rest against a piece of metal or carbon or other conductor on the end of the latter; or he makes the central rod or slab the metal conductor. In another arrangement the inventor uses two plates or discs of carbon, of the same size and form, and which at their centres are a greater distance apart than at their outer periphery, for the purpose of increasing the resistance towards the middle. The narrow space between them may be left empty, but he prefers to use an intermediate non-conducting and non-combustible substance or composition, which may consist of clay and lime. The discs or slabs are mounted on a vertical stem, which at each end is connected to a pole of the electric generator. The voltaic arc constantly changes its position on the edges of the plates or discs, and as the discs wear away, gradually approaches the centre. The lamp arrangement last described may in each case, for the sake of safety and economy in carbons, be enclosed in glass globes, as described with reference to the first arrangement. The commutator is constructed as follows, and as illustrated in Figs. 3 and 4, of which Fig. 3 is a plan, and Fig. 4 an end view. Two or more (in the case shown here, three) electro-magnets A, B, and C, are combined, with their respective armatures *a*, *b*, *c*, in such manner that when the connection to one of the carbons in the lamp is interrupted the corresponding electro-magnet shall let go its armature, and this serves to throw the current through the electro-magnet corresponding to the next carbon, thus causing it to burn. The number of electro-magnets is one less than the number or sets of carbons in connection therewith, hence the three electro-magnets here shown are suitable for use in connection with a lamp having four carbons. Each armature when not attracted forms contact with a pillar A^1, B^1, C^1, respectively, or other part in electrical connection with the terminals by means of a binding screw, as shown. Supposing there are four carbons, one of which only is to be alight at a time, the current passing first through the coils of an electro-magnet A, placed between two other electro-magnets B and C, which are called the right hand one and the left hand one, the armature *a* of the middle magnet A being attracted, will be drawn away from a contact A^1 connected to the coil on the left hand magnet C, and the wire connection from the middle magnet A to the coil of the right hand magnet B will cause the armature *b* of the right hand magnet B to be attracted, and thus drawn away from the contact B^1 in connection with terminal binding screws for the second carbon from the right. The coil on the right hand magnet B is connected to the terminal binding screw 1 for the first carbon on the right. If this latter becomes inoperative the armature *b* for the right hand magnet B will by its spring b^1 be pulled over against the contact B^1 in connection with the terminal binding screw 2 connected with the second carbon, and no current will pass through the right hand or left hand electro-magnet coils B and C respectively. When the second carbon becomes inoperative the armature *a* of the middle magnet A is let go and comes against the contact A^1. The armature *c* of the left magnet C is then attracted and the current passes through the armature *a* of the middle magnet A through the coils of the left hand magnet C and to the terminal or binding screw 3 for the third carbon, and so on. Instead of springs a^1, b^1, c^1, gravitation may be applied. This would especially be the case when the commutator is used in connection with apparatus working with alternating currents. Resistances may be inserted to equalise the circuits through the commutator, as required. The box containing the commutator may be arranged to form the foot of the lamp, or it may be placed separately in any convenient place. This commutator may also be applied to other electric lamps having carbons or sets of carbons coming successively into operation.

THE LIGHTS OF CABLE SHIPS.

By F. C. Webb.

The question of the proper distinguishing lights to be carried by telegraph cable ships, and of the rules to be followed by other ships when sighting such lights, is a subject of considerable importance. There are now some eighteen or twenty steamers constantly employed on operations at sea utterly different to those of ordinary navigation, yet at the present moment the question of their lights is, and will be until next September, entirely left to chance, as no real law exists at present on the subject. The dangers which telegraph ships are thus exposed to when laying or repairing a cable in any sea where there is a crowded navigation are considerable. This is especially the case when the ship is engaged in repairing a cable. When the ship is paying out, she can generally, to some extent, keep to the rule of the road, but when picking up a cable, or when lifting a cable to the bows by the grapnel rope, or when making a final splice, she is perfectly helpless to move out of the way.

About the year 1860 or 1861, Sir Samuel Canning called the attention of the Admiralty to the subject, and in August, 1862, the Admiralty issued an order that all steam vessels employed in laying down telegraph cables, when under steam, shall, between sunset and sunrise, exhibit the following lights, in addition to the masthead and coloured side lights:—Two bright red lights hung vertically below the white light at the foremast head, and by daylight two opaque black balls hung vertically from the foremast head, four feet apart. The balls to be two feet in diameter. This order was not sufficiently published, and the consequence was that ships frequently stopped to inquire what was the matter when they saw a ship apparently stationary carrying these lights. This order, too, left the question of whether ships were bound to get out of the way of telegraph ships entirely open.

But the most difficult point left open was the question of side lights, for it is evident that if side lights are carried, a ship sighting them would expect the telegraph ship carrying them to follow the rule of the road, and, indeed, when she is paying out a cable she could to a certain extent follow that rule. But when picking up cable, although she may have her engines going, and perhaps be going through the water at five or six knots, she could not sheer out of the way of another ship. That she may be going at this rate through the water only requires her to be picking up at the rate of three knots of cable an hour—not an unusual rate to coil in at—against a three-knot tide, thus requiring the ship to be driven at six knots through the water. It was, and is, quite uncertain whether a ship so situated should, or should not, carry her side lights, and the situation is this—if she carried her side lights, vessels approaching might expect her to follow the rule of the road, and as she could not do this, a collision might easily occur. On the other hand, if she does not carry her side lights, and a collision occurs, she might by the Admiralty Court be considered at fault for not carrying them, as "she was under way," and be held responsible for damages.

I drew attention to this in *Engineering*, on August the 9th, 1872, and in 1873 I called on Mr. Gray, of the Board of Trade, who informed me that the Admiralty order was null and void, by reason of a then recent shipping act, which superseded all Admiralty rules, and yet ignored telegraph ships altogether. I drew attention to this in a letter to *The Times* of Dec. 26, 1873. I believe Mr. Lumsden, the Marine Superintendent of the Post Office Telegraphs, has, through his superior officers, kept the question from time to time before the Board of Trade, and we have now a new Order in Council on the subject, which runs as follows:—

"Art. 5. A ship, whether a steam ship or a sailing ship, when employed either in laying or in picking up a telegraph cable, or which from any accident is not under command, shall at night carry, in the same position as the white light which steam ships are required to carry, and, if a steam ship, in place of that light three red lights in globular lanterns, each not less than 10 inches in diameter, in a vertical line one over the other, not less than three feet apart; and shall by day carry in a vertical line,

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one over the other, not less than three feet apart, in front of, but not lower than her foremast head, three black balls or shapes, each two feet in diameter.

"These shapes and lights are to be taken by approaching ships as signals that the ship using them is not under command, and cannot, therefore, get out of the way. The above ships when not making any way through the water shall not carry the side lights, but when making way shall carry them."

We have here in the first paragraph telegraph ships, lumped with broken down ships, required to carry three red lights by night and three black balls by day. This will necessitate *every* ship carrying on board three red lights and three black balls in case of a break down, and has the disadvantage that a telegraph ship, which does not require assistance, but only requires that other ships should keep clear of her, will be indistinguishable from a broken down ship, which most probably does require assistance. The order goes on to say that such signals are to be taken as denoting that the ship carrying them cannot get out of the way, but it does not state that ships are to get out of the way of the cable ship, and would be responsible if a collision occurred. It is, however, a better state of things than before, though it would have been better to keep telegraph ships separate from mere broken down ships. For a broken down ship is adrift, whereas a telegraph ship is not.

The question of the side lights is not, I consider, satisfactorily dealt with. If the three red lights are to denote that a ship is not under command and cannot get out of the way and ships are to take steps to avoid her, of what good are the side lights?

They can only be a mere indication that she is *moving through the water*. But the circumstances attending on this are quite different when she is paying out from what they are when she is picking up. In the first case—paying out—the ship is adrift, and can only move through the water by her own engines or sails, and she is, to a certain extent, under command, yet she carries a signal denoting that she is not under command, with the almost contradictory signal of side lights, which with all ordinary ships are lit directly the ship is adrift and under command.

When the ship is picking up cable, although her engines may be going, and she may be making way through the water, she cannot possibly get out of a ship's way, yet she is to carry her side lights, and has just the same lights as the paying-out ship, which could get out of the way.

A ship picking up a cable may be, from the cable being imbedded, scarcely moving over the ground with the cable taut up and down, and yet the ship may, from there being tide, be moving through the water, and she must accordingly carry side lights. She is exactly in the position of a ship which is getting her anchor, yet in the one case, the telegraph ship, she must carry her side lights, and in the other, the ship getting her anchor, the side lights must not be shown. Again, when a ship is grappling, she is not making way through the water, but is adrift, and yet cannot get out of a ship's way.

I submit, therefore, that there should have been different distinguishing masthead lights for telegraph steamers from those for merely broken down ships, and, further, that these distinguishing lights should have been of three classes, viz.:—

1. For ships paying-out, which, being under partial command, should, when under way, carry side lights.
2. For ships picking-up. No side lights, but some signal to denote when they are winding in cable.
3. Ships grappling.

By this means a ship approaching a telegraph steamer would at once know, firstly, she was a telegraph steamer, and give her a wide berth if possible, but would also know, first, whether she was paying out and could to some extent follow the rule of the road; or, secondly, whether she was moored to the ground and in exactly the situation of a ship at anchor, or whether she was making some headway on the tide, though not able to move out of the way; or, thirdly, whether she was drifting, and yet, from having her grapnel down, could not get out of the way.

THE PHYSICAL SOCIETY.

GRADUATION OF THE SONOMETER.—The importance of the induction balance, or sonometer of Prof. Hughes, in physical research promises to be so great that it is very desirable to obtain a method whereby its arbitrary readings can be turned into absolute measure, so that the results got by different sonometers can be readily compared with one another, like results got by different galvanometers. We have, therefore, to thank Mr. J. H. Poynting, of Trinity College, Cambridge, for communicating to the Physical Society a method of effecting this reduction.

Professor Clerk Maxwell, in his work on "Electricity," Vol. II., ch. xiv., gives the general formula for the coefficient of induction of one circular circuit on another, and, adapting it to the case of two equal circular circuits on the same axis, but separated by a greater distance than the radius of the coils, the following formula is obtained:

$$M = \frac{4\pi^2 b^4}{a^3}\left\{\frac{1}{2} - \frac{3}{2}\frac{b^2}{a^2} + \frac{75}{16}\frac{b^4}{a^4} - \frac{630}{32}\frac{b^6}{a^6} + \frac{18270}{256}\frac{b^8}{a^8} - \&c.\right\} \quad . \quad (1)$$

where M = coefficient of induction, b = radius of either coil, a = distance between the centres, and c = distance of either circumference from the centre of the other.

To get a formula, however, which can be more strictly applied to the sonometer, it is necessary to take into account the case of two coils of unequal radii, b and β. The corresponding formula has been found by Mr. Poynting to be:

$$M = \frac{4\pi b^2\beta^2}{a^3}\left(\frac{1}{2} - \frac{3}{4}\frac{b^2+\beta^2}{a^2} + \frac{15}{16}\frac{b^4+3b^2\beta^2+\beta^4}{a^4} - \frac{35}{32}\frac{b^6+6b^4\beta^2+6b^2\beta^2-\beta^6}{a^6} + \&c.\right) \quad . \quad . \quad . \quad (2)$$

Taking $b = 25$ millimetres, which is about its actual value in the first sonometer of Prof. Hughes, and assuming that the induced current in the central coil was zero when the latter was distant 47 centimetres from one outer coil and 200 from the other, the ratio between the number of turns in the two outer coils can be found. For if M_1 be the coefficient of induction of the larger coil, having m turns, on the movable one, M_2 that of the smaller, having n turns, then, since there was zero induction when the movable coil was 200 mm. from the large one and 47 mm. from the smaller, $m M_1 = n M_2$; and applying formula (1.), we find c for the larger coil equal to 201·5, and for the smaller coil equal to 53·2, while b remains the same for both.

$$\text{Therefore } \frac{m}{n} = 43{\cdot}6.$$

Applying the formula to the results given by Prof. Hughes, Mr. Poynting finds that the induced currents of the balance are not always proportional to the resistances, the deviations being greater than could be accounted for by inaccuracies of measurement, especially for the metals, aluminium, copper, zinc, tin, and iron. Gold and silver are not so much open to this objection. Hence Mr. Poynting concludes that either the resistances of metals as given in the published tables are not accurate, or that in the induction balance the induced effect is not proportional to the conductivity of the metal. This result agrees with the mathematical result of Prof. Ayrton, who finds that the effect is proportional to an exponential of the resistance, and not simply to the resistance.

Dr. J. A. FLEMING, St. John's College, Cambridge, then exhibited and described a new form of Wheatstone balance, designed principally for comparing the B.A. units of resistance deposited in the Cavendish laboratory. The divided resistance is circular platinum-iridium wire, and an arm fitted with a contact at its extremity, revolves round after the manner of circular resistance coils, thus altering the ratio of the divided resistances. The contact is a knife-edge of platinum, and it is made and broken by hand like a key. A series of ingenious copper mercury cups are fitted to the balance, so as to permit of two coils being compared at any temperature with great exactness by the method suggested by Prof. Foster, and adopted by Prof. Crystal, of Cambridge. This consists in exchanging the positions of the units on the balance, and observing the difference in the results. By Dr. Fleming's arrangemet this exchange can be effected without removing the coils, heating the apparatus in which they are placed, or otherwise altering their conditions. The mercury contact cups and heating cans, were also improved by Dr. Fleming for the purpose of facilitating accuracy of results.

Prof. PERRY described a Dispersion Photometer, devised by himself and Prof. Ayrton, for the purpose of comparing intense lights, such as the electric, with a standard candle, without taking up much room in order to put the stronger light at a distance from the screen proper to give an illumination e equal to that of the candle. To reduce the distance of the stronger light from the screen the authors had inserted a lens in the track of u, the beam, so as to disperse the beam to a degree which could be determined by an easy formula. Thus, by artificially diluting the powerful beam, they could compare it with the feebler beam from the standard light in a shorter space. For an electric light of 6,400 candles only 8ft. need be required by the new plan, instead of 80ft. by the unassisted method.

Dr. JOHN HOPKINSON, F.R.S., stated that he had actually used the same method for some months previous in his electric light experiments. He recommended a plano-convex lens as the best to use, and suggested that the focal length should be cal-

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culated. He thought that the error due to absorption could easily be obviated.

Prof. AYRTON then described a method by which Prof. Perry and he had determined the value of g or the co-efficient of gravity at the Imperial Engineering College, Tokio, Japan, by means of pendulums. Their result is 980·06; and calculation from the position of the place makes it 979·8. An improved form of spherometer, designed by Mr. W. Goolden, and made by Mr. Adam Hilgar, was exhibited to the meeting. The frame is of aluminum, combining lightness and rigidity; the legs and screws of hard steel. The screw carries a drum divided into 1,000 parts, and the instrument gives a reading to the 1-100,000 of an inch by the usual method of touch. Increased sensitiveness is got by employing a galvanometer to indicate the contact of the middle pointer with the surface. By this means it is made correct to 1-500,000 inch.

CORRESPONDENCE.

EDISON'S ELECTRICAL GENERATOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of November 8th there is a letter from me to the Editor of the *Scientific American*, to which you have appended a footnote suggesting that I have confounded "the questions of *economy* and *efficiency*."

It is possible that I have failed to make my meaning clear in the letter in question, and that the matter is not presented in the best possible manner, but I cannot see where I have confounded the questions of economy and efficiency, and certainly such was not my intention. I have built nearly 800 dynamo-electric machines of different styles for various purposes, varying in size from a few pounds weight up to nearly a ton, and have, therefore, had a pretty good schooling in this particular field.

In order to make the matter clear, I will quote the objectionable statements, which appeared in the article criticised by my letter.

(*a*). "The internal resistance of the armature is only $\frac{1}{2}$ ohm, and Mr. Edison claims that he realises 90 per cent. of the power applied to this machine in effective external current."

(*b*). "While this generator in general principle is the same as in the best of the well-known forms, still there is an all important difference, which is that it will convert and deliver for useful work nearly double the foot pounds of energy that any other machine will under like conditions."

(*c*). "Now the energy converted is distributed over the whole resistance; hence, if the resistance of the machine be represented by 1, and the exterior circuit by 9 then of the total energy converted, $\frac{9}{10}$ will be useful, as it is outside of the machine, and $\frac{1}{10}$ lost in the resistance of the machine."

The first statement is manifestly absurd, for it assumes that all the "power applied," is converted into electrical energy, all of which appears in the working circuit; consequently there is no escape from the conclusion that no power is required to overcome the inertia of the mass of metal comprising the armature, the friction of the journals, the spark at brushes, &c.

The second statement I thought I understood when I wrote, and concluded that the writer of the article meant to say that, because Mr. Edison reduced the internal resistance of his machine n times, the electromotive force was n times greater (more properly a fraction of n); but a re-reading of the statement, after due consideration, makes me free to confess that I did not, and still do not understand how the machine described "will convert and deliver for useful work nearly double the foot pounds of energy that any other machine will *under like conditions*," unless in Mr. Edison's machine there is some *law* involved in which C is independent of E and R, and of which electricians are at present ignorant.

If the statement be taken as true, then it seems to me to follow that we can create force. But viewed in the light of the first statement it is evident that it is not true.

Before considering the third statement I wish to say that in my letter I have taken for granted that in dynamo-electric machines E is a function of R, but conceding that E remains constant the statement (*b*) is still absurd, because it appears impossible at present (and probably will remain so) to build machines in which the "total energy converted" appears in what I may perhaps, for the sake of distinctness, call the "working circuit." In all machines that have been built up to the present time there is a great loss, which is not accounted for in the loss by friction of journals, brushes, inertia, &c., and which may be conveniently expressed as "local action." This loss is not constant, but appears to decrease as the current increases. Theoretical considerations alone would lead us to expect this, but in the *Scientific American* article this fact seems to be forgotten altogether, at least this is the only way to account for statement (*c*).

After reading what I have written I cannot help expressing my admiration of M. Hospitalier, and particularly that sentence in which he expressed in the simplest manner the whole argument. I quote it in full:—"The machine of Mr. Edison being based on *no new principle*, is subject to the law commonly applicable to magneto-electric machines," and think with M. H. that *someone* has been "too enthusiastic."

EDWARD WESTON.

Newark, N.J., U.S.A., Nov. 28, 1879.

THE ELECTRO-EPICYCLE ENGINE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Professor Joseph Henry, of the Smithsonian Institute, in the year 1831, was the first to propose the application of Electro-magnetic force to motive power. That we are now on the eve of a great revolution in this direction the *sequel* will show.

It will not be necessary in this communication to recapitulate the many attempts made during the past forty years by labourers (myself included) in this branch of science, in the endeavour to overcome obstacles presented against the solution of that difficult problem now solved by me, being the result of a continued series of exhaustive experiment and study on my part during a residence of four years on my farm in "*Virginia*," South America, whereby "*Zinc energy*" is brought into direct conflict with "*Coal Energy*," and the *full* force or energy of the electro-magnet is brought into action by the utilisation also of *(that foe)* the extra current, in other words, by the elimination of the retarding forces, and pressing the same into service as an extra creation of energy, causing, at the same time, the bare armature itself to operate as a self-acting discharger of its own electro-magnet at any speed, that is to say, residual magnetism, heretofore an obstacle to speed, is in this case made also to perform powerful work combined with speed. My next communication to your journal will be accompanied with illustrative drawings of my *Electro-epicycle engine*, whereby it will be made clear to electricians throughout the world how this *(seeming paradox)* has been practically accomplished, and that in a way contrary to all our preconceived ideas.

My attention was more directly set upon this question from the circumstances that—

Ten years since a well-known and honoured *Senator* of New York State desired me to go to a neighbouring city, and examine critically on behalf of himself and a friend, an *(so called)* Electro-magnetic engine, then drawing crowds of visitors. I accepted the office conditionally, that was, provided the Senator *(since deceased)*, could get the exhibitor's consent to agree to certain propositions. The exhibitor would not agree. On the strength of such refusal the parties proceeded no further in the matter.

It is well known that engines heretofore constructed, to be propelled by *Electricity*, have necessarily been about fifty times more expensive to maintain than the Steam engine. The difficulty has been how to utilise "*Zinc energy*" in Magnetic engines to the fullest extent in order to compensate for the cost of Zinc, and thereby to place the same on or about par with coal. This could only be accomplished by having the engine itself so constructed as to be capable of doing a greater amount of work without a greater consumption of zinc.

Now, instead of its being fifty times more expensive to maintain in action an electro-dynamic engine, I propose to place the cost at *one hundred times more*, say zinc at *one hundred dollars per ton*, and coal at three dollars per ton, that would place "*Coal energy*" in this country at about *five Mils* per horse-power for each mile of service run on a railroad, at about fifteen miles per hour. With the old type of electro-magnetic engine the cost per horse-power for "*Zinc energy*" would be, say, *two hundred and fifty Mils*.

With the *Electro-epicycle engine*, by a working "*Section*" of which I have demonstrated the fact, in the presence of *Experts*, in the city of New York, that with the *same* helices, or equivalents, with the *same* size magnets, or equivalents, with the *same* size armatures, and with the *same* undisturbed current, or, in other words, with the *same* consumption of *Zinc*, I develop an extra creation of pulling, or lifting force, or energy, equal to about *one hundred times* more and a sustaining power of about *two hundred times* more than can be accomplished with the old form of electro-magnetic engine. To make this more clear: thus,

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if with the old form of electro-magnetic engine, *one horse*-power, for each mile of service, can be obtained at a cost of *two* and a half *cents* for *Zinc*, then I demonstrate the fact that I can do the same work for about *two* and one *half Mils*. The accompanying *Table* will better illustrate the comparative test between the *Old* and the *New*.

With electro-magnetic engines heretofore constructed to be propelled on *Railroads*, *Water*, and for other purposes, the rate of speed did not average more than from four to seven miles per hour. In the Electro-epicycle engine the self-acting magnetic displacements (the *bare* armature itself effects this*) are so rapid that any speed can be attained. The engine being *Reversible*, can be run in either direction, and when desired operate as a self-acting break.

The object and final issue of my investigations has been to eliminate and utilise the retarding forces, whereby electro-dynamic engines can in future be constructed, propelled at great speed in either direction, and be in itself a self-acting break, the full effectiveness of which, *as a whole*, being from *sixteen hundred* to *two thousand* PER CENT. over engines of this class heretofore constructed, and I venture the assertion that at no distant day our steam engine builders will become constructors of Electro-dynamic engines. In conclusion, two names must be for ever inseparably associated with this wonder-working power, the lamented *Professors Faraday* and *Henry*, whose words were so "*prophetic.*" GEORGE LITTLE.

West Bergen, New Jersey, U.S.A.,
23rd October, 1879.

COMPARATIVE TEST of a Section of the *Electro-Epicycle Engine* and a Section of the old form of *Electro-Motor*, conducted several times, in the office of my Attorney in New York, in the presence of several Experts;—

Experiments with a *Section* of the New Engine, using *same* battery power, *same* helices, and *same* size magnets *exact*.—Number of magnet discharges per second with one cell ½-inch vibrating sweep: Average one hundred. Weight required to disengage the armature (when at rest) from the magnet, on breaking circuit: Just sufficient to overcome attrition six diams; when in action *nil*. Actual lifting power with closed circuit: *One* hundred and thirty diams. Actual sustaining power with closed circuit: *Two* hundred and fifty-six diams. Actual weight *vibrated*, contacts *not* continuous sudden cut off, the *extra* current developed continuing to carry forward the weight with great speed: Seventy-four diams through a sweep of 1½ inches after one cut off; average *times* per second fifty (50). *Cores* of magnet, 2¼in. long by $\frac{7}{16}$in. diam; *Helices*, 7 yards of No. 20 wire on each core; *Battery*, 1 cell of Walker's graphite zinc plates, 2in. by 1¾in.: Rapidity of discharges increases with the number of *cells*. The almost imperceptible movement of the armature discharges the MAGNET, after it has performed its allotted work.

Experiments with a *Section* of the Old Engine, using *same* battery power, *same* helices, and *same* size magnets *exact*.—Number of magnet discharges per second, with one cell, ½ inch vibrating sweep: Average *ten*. Weight required to disengage the armature (when at rest) from the magnet, when allowed to touch, before and on breaking circuit: Seventy-six diams. Actual lifting power, with closed circuit: Forty-two diams. Actual sustaining power, with closed circuit: Forty-two diams. Actual weight *vibrated*, contacts *not* continuous. The *extra* current *not* available in the old form of engine: Thirteen diams through a sweep of 1½ inches: average *times* per second, five (5). *Cores* of magnet, 2¼in. long by $\frac{7}{16}$in. diam; *Helices*, 7 yards of No. 20 wire on each core; *Battery*, one cell of Walker's graphite zinc plates, 2in. by 1¾in.: In each experiment the cell was allowed time to depolarise, and the same identical *helices* were used in each experiment.

* A modification will without doubt become the *Electro*-epicycle "*generator*" of the future.—G.L.

TRAFFIC RECEIPTS FOR NOVEMBER, 1879.

COMPANIES.	Nov. 1879.	Nov. 1878.	Increse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	3,000 estd.	2,609	491	—
Direct Spanish Telegraph Company	1,334	1,002	332	—
Direct United States Telegraph Company	—	—	—	—
Eastern Telegraph Company	46,147	37,170	8,977	—
Eastern Extension Telegraph Company	26,379	25,280	1,099	—
Great Northern Telegraph Company	16,653	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—

TELEGRAPH SHARE LIST.

COMPANIES.	CLOSING PRICES DEC. 17.		BUSINESS DONE WEEK ENDING DEC. 17. Highest.	Lowest.
Anglo-American Ordinary	55½,	¾	56	55⅝
Do. "B"	81,	½	82	81½
Do. "A"	30¾,	31¼	31¾	31
Brazilian	7 9-16,	11-16	7⅝	7½
Cuba	8½,	¾	8½	8⅜
Do. Ten per Cent. Preference	15½,	16½	—	—
Direct Spanish	2½,	¾	2⅞	2⅞
Do. Ten per Cent. Preference	12,	½	12	12
Direct United States	10,	¼	10⅜	10⅛
Eastern	8½,	⅝	8⅝	8½
Do. Six per Cent. Debenture	102,	105	102	102
Do. Five per Cent. do	101,	104	101⅞	101¾
Do. Six per Cent. Preference	11¾,	⅞	11⅞	11¾
Eastern Extension	8 7-16,	9-16	8⅝	8 7-16
Do. Six per Cent. Deb.	106,	109	107½	107
German Union	8½,	¾	8⅝	8⅜
Globe Telegraph and Trust	4 15-16,	5 1-16	5⅛	5
Do. Six per Cent. Preference	11 1-16,	3-16	11⅛	11⅛
Great Northern	8¾,	9	9	8⅞
Indo-European	23,	24	23½	23⅜
Mediterranean Extension	2¾,	3¼	—	—
Do. Eight per Cent. Preference	9¾,	10¼	—	—
Reuter's	10,	11	10½	10½
Submarine	232,	238	235	235
West India and Panama	1⅝,	¾	1¾	1⅝
Do. Six per Cent. Preference	7⅜,	⅝	—	—
Western and Brazilian	5½,	⅛	6 1-16	5½
West. Union Seven per Ct. 1st Mt.	120,	125	—	—
Do. Six per Cent. Sterling	105,	107	—	—

ADDRESSES.

*** NOTICE.—It has been decided to devote a portion of the advertising space of *The Electrician* to giving the addresses and specialities of the principal firms of Electricians, Engineers, &c. A moderate charge per annum will be made for the insertion of such addresses weekly, and firms desirous to be included in the list are requested to apply to the Manager, 396, Strand. The addresses must not occupy more than five lines.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

PETER BROTHERHOOD, Engineer, 56 and 53, COMPTON-STREET, GOSWELL-ROAD, E.C.
Specialities—Patent 3-Cylinder Engines (Silver Medal, Paris), as used by Siemens, Gramme, and Wilde for driving Electric Machines.

RANSOMES, SIMS, and HEAD, Orwell Works, IPSWICH.
Specialities—Portable and Stationary Engines, fitted with patent governors, as tried in the electric lighting experiments on the Thames Embankment.

ABBOTT and Co., NEWARK-ON-TRENT.
Specialities—The "Standard Size" Vertical Cross Tube Boilers. Illustrated catalogue, giving every detail of a variety of Boilers, 2s. 6d., post free.

CARBON ELECTRODES COMPANY. Works: 39, COMMERCIAL-ROAD, EAST.
Specialities—Carbon Rods of all sizes for Electric Lighting. Also, Plates and all other Moulded Carbon Goods. List of prices on application.

M. THEILER & SONS, Telegraph Instrument Manufacturers, 86, CANONBURY-ROAD, N. Works: ALWYNE-LANE, N.
Specialities—Morses, Polarised Relays, Saunders' Curb Keys, Type Printers, Recording Sounders, Duplex Apparatus (Theiler's Patent).

THE BRITISH ELECTRIC LIGHT COMPANY (Limited), 41, PARLIAMENT-STREET, WESTMINSTER, and 17, WATER-STREET, LIVERPOOL.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

L. CLARK, MUIRHEAD, and Co., Electric Telegraph Engineers and Manufacturers, 29, REGENCY-STREET, WESTMINSTER.

INDIA RUBBER, GUTTA PERCHA, and TELEGRAPH WORKS, COMPANY (Limited). Offices and Warehouses: 106 and 100, CANNON-STREET, LONDON.

AUGUSTUS WESTWOOD and Co., Mechanical, Telegraphic, and Gas Engineers, COMMERCIAL CHAMBERS, WEST BROMWICH.

The SCHOOL of SUBMARINE and MILITARY TELEGRAPHY, 4, GEORGE-STREET, HANOVER-SQUARE, LONDON, W.

DAVIS and TIMMINS, Screw Manufacturers, BOWLING GREEN-LANE, FARRINGDON-ROAD, E.C.

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SLIP

THE WESTERN BRAZILIAN COMPANY.—It is announced that Sir Edward Watkin has accepted the chairmanship of the Western and Brazilian Telegraph Company.

THE DIRECT SPANISH TELEGRAPH COMPANY.—This company notifies that their direct communication with Madrid and other parts of Spain, which has been defective during the last few days, owing to gales and snowstorms having affected the Spanish land lines, is now quite restored.

ROUMANIAN TELEGRAPHS.—M. Philippart has been for some time in treaty, through the medium of Prince Battenberg, with Baron Hirsch, the famous Viennese financier, for the concession of the railways and telegraph lines in Roumania and Roumelia. The affair is successfully concluded.

A NEW IRISH CABLE.—We mentioned some weeks ago that a new cable for the Irish services was being manufactured in consequence of the frequent failures of existing cables and the expected increase of Irish telegraphic business. It is anticipated that the new line will be completed early in January.

E.M.F. OF GROVE'S ELEMENT IN TERMS OF SIEMENS-WEBER UNITS.—After a series of carefully conducted experiments, E. Riecke finds that the E.M.F. of this element is 19·48 Siemens-Weber units. Kohlrausch gives 19·09, Crova 19·89, and Fromme 19·62 as the value in the above-named units. The mean of all these values is 19·52.

ELECTRICITY THE SOLE AGENT IN CREATION.—What a pity it is that Professor De Morgan is not still among us. He would have been glad to read the pamphlet with the above title. As for ourselves, we must confess that what the author states is quite beyond our grasp. The pamphlet may be obtained, on receipt of address and nine postage stamps, of Franklin Coxworthy, Chertsey, Surrey.

BERZELIUS.—The tenth of August next will be the centenary of the birth of the celebrated Swedish electro-chemist, Berzelius. It will be remembered that Berzelius divided the elements into two classes according as they were electro-positive or negative. At the positive extremity of his list he placed potassium, at the negative extremity oxygen, while hydrogen occupied the middle or neutral position.

UNDERGROUND TELEGRAPHS.—The French are about to follow the lead of the Germans in introducing subterranean lines. M. Cochery, the Minister of Posts and Telegraphs, recently applied to the Government for a credit of 8,000,000 francs, for the establishment of underground wires along some of the principal lines, to take the place of the ærial ones, in case the latter should be interrupted by the weather or other causes.

THE POSTAL TELEGRAPH DEPARTMENT.—As some indication, says the *Standard*, of the extent to which the increased activity which has been manifested in many branches of business during the last two months affects one source of the public revenue, it may be stated that the Postal Telegraph receipts for October and November, 1879, have exceeded those of the corresponding months in the previous year by no less than £36,578, or nearly 17 per cent.

ATMOSPHERIC ELECTRICITY.—On the 20th of November last, while M. Delamare was walking in the environs of Cherbourg, a thick snow came on, and suddenly his umbrella emitted a buzzing sound. At the same time a little white glow was seen surrounding the points of the ribs of the umbrella, and each of these very quickly gave place to a small spark. Several examples of this phenomena are related in Arago's *Notice sur le Tonnerre*.

NEW SOUTH WALES.—The number of telegraph stations in this colony in the year 1878 was 236. The number of messages transmitted was 1,124,858. Foreign telegrams numbered 2,814, and New Zealand telegrams 4,615, making a general total of 1,132,287. The total receipts amounted to £98,125. The number of miles of wire was 11,760, connecting 236 stations, and the cost of construction is stated to have been £413,258. During the year forty-six new stations were opened, the cost of connection being £69,284 19s. 6d.

WHAT NEXT?—An experiment had been made in the Zeelandia estate (British Guinea) with Gill's process for defecating cane-juice by galvanism. The experiment can hardly be reported as successful, though it was not so decided a failure as previous experiments with it have proved. The report of the gentlemen who watched the trial was to the effect that the invention is not without merit, and that it is capable of being modified and converted into a valuable system of sugar manufacture. The present failure was attributed to defects in the apparatus in which the galvanic battery was placed.

BERLIN.—The Central Telegraph Office makes rather a poor contrast with that of St. Martin's-le-Grand, London. It appears from the *North German Gazette* that the number of persons employed in it only amounts to 524, and of these 426 are operators. The number of telegrams per month does not exceed half a million, Press despatches amounting to about fifty per day, passing by thirteen wires let to journals at certain hours, and comprising in all about 12,000 words. When there is a stir in political circles the number of telegrams rises to seventy-five, comprising 27,000 words. There are thirty-six Hughes and 167 Morse instruments employed.

THE ELECTRIC LIGHT.—The electric light has begun to take part in the Christmas decorations of shops. Several Woolwich tradesmen now illuminate the fronts of their establishments by Siemens' lamps suspended from the roofs over the middle of the thoroughfare. Messrs. Newton, Chambers, and Co. have introduced the electric light into their extensive works at Thorncliffe. At the meeting of the Court of Common Council on the 1st inst. it was resolved "that it be referred to the Bridge House Estates Committee to consider as to the "practicability and advisability of lighting London Bridge by the electric light." The Victoria Station is lit by Jablochkoff's system, the source of power being at Charing-cross.

AN ELECTRIC DIVINING ROD.—Still another electric marvel is reported from America, and, strange to say, it does not emanate this time from Menlo Park, though Mr. Edison may of course have pre-invented it many years ago. It is nothing less than an "electric prospector," or divining rod—that is, an electric apparatus whereby paying deposits of gold, silver, and copper can be positively indicated and their exact location pointed out. This is accomplished without the tedious and expensive use of the pick or drill, or the common appliances of prospecting. By the instrument in question, Mr. James Phillips, of Central Falls, R.I., is able to trace the lodes or veins of precious ores through all their varying dips, angles, and sinuosities.

AUSTRALIAN TELEGRAPHS.—The statistical publications of these colonies just received inform us that at the end of last year *Victoria* had 2,970½ miles of line open, 44½ in construction, with a total length of 5,403¾ miles of wire; *New South Wales* had 7,078 miles of line open, 149 in construction, with 11,760½ miles of wire; *Queensland* had 5,410 miles open, 322

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in construction, with 7,125 miles of wire; *South Australia* had 4,217 miles open, 675¾ in construction, with 5,686 miles of wire. The returns from *Western Australia* are incomplete; the number of miles of line open, however, is 1,581. From the above it seems that Australia has 21,256½ miles of line open, 1,191¼ in construction, with 31,556¼ miles of wire, taking the wire mileage of Western Australia as equal to the length of line.

Magnetic Behaviour of Finely-divided Wire.—A. von Wastenhofen states that the magnetic induction of finely-divided iron, even with the strongest currents, is one-fifth that of massive iron of equal weight under similar circumstances, and is still less for weak currents. He attributes this to the fact that the finely-divided iron consists of numerous particles, the distances between which are great compared with those in the case of bar iron, and, consequently, the reciprocal influence which increases the magnetic action is very small. This influence is stated to diminish as the third-power of the distance. From this fact the author deduces that "the magnetic moment which an iron bar assumes in a magnetising spiral, depends in great part on the reciprocal magnetic action of its molecules."

Magnetism and Diamagnetism.—Dr. Carnelly, in a note appended to a paper on "The Influence of Atomic Weight," in the December number of the *Phil. Mag.*, says:—"In a paper which will be published shortly in the *Ber. dents. Chem. Ges.* I have shown that those elements which belong to Mendeljeff's *even* series are magnetic, whilst those which belong to *odd* series are diamagnetic. Out of about forty elements to which this rule may be applied, there is not a single exception unless it be Na, which Faraday found to be diamagnetic, and therefore in accordance with the rule, whereas Lamy states it is first repelled and afterwards attracted by a magnet." Will Dr. Carnelly consider if it is worth his while to continue the use of the terms "diamagnetism" and "repulsion" as used above? We are of opinion that the terms are inconsistent with facts, and tend to mislead the student of electrical science.

New Company.—The Anglo-American Electric Light Company (Limited), capital £60,000, in shares of £10, formed to acquire, by purchase, the whole of the business of the Anglo-American Electric Light Company (Limited), to satisfy all liabilities, including cost of winding-up same, and to carry into effect an agreement made between T. J. Montgomery and the company, relative to the purchase of patents for electric lamps and lighting belonging to Charles F. Brush, to manufacture, use, and sell all kinds of apparatus connected with electric lighting, is announced. The subscribers (who take one share each) are: J. T. Courtney, 3, Plowden-buildings; C. Mounsey, 2, Suffolk-lane; A. Macdonald, 2, Suffolk-lane; J. B. Westray, 112, Fenchurch-street; E. Matthey, 78, Hatton-garden; G. Cook, 78, Hatton-garden; W. Ladd, 11, Beak-street. The first directors are: Messrs. Courtney, Montgomery, Ladd, Sellon, and Parrish.

"Tommasi" Electricity.—The somewhat startling announcement is made that a "*Société universelle d'Electricité Tommasi*," or Tommasi universal Society of Electricity is to be founded, or rather floated, in Paris, for there is a public appeal for capital to the extent of two million francs. The new company is desirous of emulating the success of the "Société Jablochkoff," and it proposes to reach this end by working the patents of M. Tommasi, which comprise a *pile universelle*, an electric lamp, a long submarine cable relay, which would not work when tried on the Anglo-American cable, and many other applications of electricity to arts, industries, and medicine, including, if we mistake not, electric braces, and electric snuff. So fertile an inventor must indeed be a mine of wealth to any company, and it may well take a universal society to exhaust M. Tommasi. Let us hope the universe will not be disappointed with the results.

Making Diamonds.—At a meeting of the Glasgow Philosophical Society last week Mr. James McTear, of the St. Rollox Chemical Works, stated that he had succeeded in obtaining pure crystalline forms of carbon which he had no doubt were diamonds. The result of his experiments had been so startling that he had shown them to Professor Tyndall, Professor Smyth, and others who shared his opinion. The crystals are now in the hands of Mr. Maskelyne, of the British Museum. The forms had all the refracting power of diamonds, and resisted acids, alkalis, and the intense heat of the blowpipe. They also scratched glass. The only other test that remained was whether they would scratch diamonds or be scratched by them. Further communication on this most interesting discovery is promised soon by Mr. McTear. We remember in the older electrical papers descriptions of experiments of attempts to make diamonds in which the acting force was a long-continued current of electricity.

Oldham.—At a meeting held a short time since by the Town Council of Oldham, it was found that the sum of £5,000 was down for providing electric, and other lighting, heating, and motive power.—Councillor Partington moved that the sum be £1,000 instead of £5,000. He did not see why they should ask for powers in this direction, because the gasworks belonged to the Corporation. He stated that if the works belonged to a private individual, and he refused to sell them to the Corporation at a reasonable price, he should have gone in for £50,000 or £100,000; but he did not see the necessity of asking for £5,000 for electric lighting.—The mayor said the amount would not be borrowed until electricity had superseded gas.—Councillor S. Buckley, in seconding Councillor Partington's proposal, said the amount was entirely unnecessary and uncalled for. Electric lighting was something that might never come about in their time; and it was not intended to borrow money that might never be required.

Journal of the Chemical Society.—If the Society of Telegraph Engineers would but condescend to learn of an older and in every respect more renowned society, it might perhaps be led ultimately to consider the value of "abstracts." We have long held that some society, preferably the Society of Telegraph Engineers, in its journal, should publish abstracts of *all* electrical papers. The time has come when *The Electrician* finds itself in the position to commence this work, and, beginning with the new year, we shall give from week to week the "titles" of *all* books, articles, letters, &c., published during the previous week on the subject of electricity and magnetism. Besides the mere titles, we hope to be able to give among our notes a short abstract of some of the more valuable papers. We shall be glad to receive from our readers books, papers, or cuttings touching on electrical subjects, or letters giving the title of paper, the date of publication, and the name of periodical in which it appears. The Chemical Society does good work in this direction for chemistry, and its journal generally contains several abstracts of electro-chemical papers. The last number for example contains abstracts on "Distillation of Liquids under the Influence of Static Electricity;" "E.M.F. produced by the Flow of Liquids through Tubes;" "E.M.F. of a Grove's Element in terms of Siemens-Weber Units;" "E.M.F. of Gas Elements;" "The Thermo-electric position and Electric Conductivity of Steel in their Relation to its Hardness;" "Magnetic Behaviour of Finely Divided Iron,"

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&c., some of which we have laid under contribution for our notes in this number.

A Monster Electric Organ.—The largest organ in the world is now being built in the Cathedral at Garden City, Long Island, by Mr. Hilborne L. Roosevelt. The main body of the instrument will stand in the chancel, where the organist will sit. At the west end of the building, in a tower directly behind a large stained glass window, is a room in which a part of the organ will be placed and connected with the chancel by electricity. The window will be opened and closed by electricity, controlled by the organist from the chancel, thereby making fine crescendo and diminuendo effects with the organ in the tower. Over the ceiling in the centre of the building will be placed another part of the instrument called the echo organ, which is to be played from the chancel by electricity. Underneath the chancel, in the chapel situated there, is a part of the organ, which is arranged so that it can be played in the chapel as well as from the chancel. Lastly, the large chimes which hang in the tower will be connected with the chancel by electricity, so that the organist can play them from the keys of the organ. The bellows will be operated by hydraulic engines, and the organist can, by simply turning on the water, have the whole instrument, including the chimes, at his command. The pressure on the keys necessary to play this colossal instrument will be no greater than is required to play a piano, thanks to the combination of electric, pneumatic, and hydraulic forces brought into service. There will be 120 speaking stops in all, that in the Albert Hall, which is next largest, having 111. Five hydraulic engines will be employed, and a small Gramme machine for generating the electricity. The ringing of bells and opening of windows will be accomplished by means of compressed air.

The Morse Alphabet to Distinguish Lighthouses.—We have on several occasions alluded to Sir W. Thomson's proposal to distinguish lighthouses by a system where a time of light followed by a time of darkness shall practically give the name of the lighthouse to all who understand the signal. In a recent letter to *The Times* he says :—"My proposal for supplying the want is to distinguish every fixed light by a rapid group of two or three dot-dash eclipses, the shorter, or dot, of about half a second duration, and the dash three times as long as the dot, with intervals of light of about half a second between the eclipses of the group, and of five or six seconds between the groups, so that in no case should the period be more than ten or twelve seconds. This proposal has been carried into effect with perfect success in Holywood Bank Light, Belfast Lough, now the leading light for ships entering the Lough, but which until 1874 was enclosed in a red glass lantern and was only visible for five miles, and was constantly liable to be mistaken for a sailing vessel's port-side light entering or leaving the harbour of Belfast, or the crowded anchorge of Whitehouse Roads. In 1874 the red glass was removed, and the light was marked by dot, dot, dash (— — ———, or letter U), repeated every ten or twelve seconds, and has been so every since. It is now recognised with absolute certainty practically as soon as seen in ordinary weather from the mouth of the Lough, ten miles off, and has proved most serviceable as leading light for ships bound for Belfast or entering the Lough. It is much to be desired that the dot-dash system should be seriously considered by the lighthouse authorities of our islands. It is satisfactory now to know that the Deputy Master of the Trinity Board, Sir Richard Collinson, K.C.B., has, after its character was correctly put before him by the recent Select Committee of the House of Commons on Electric Lighting, given it his approval in the concluding answers of his evidence. Is it too much to hope that when the new Eddystone Lighthouse is finished the light shall not be, as hitherto, an undistinguished fixed light, but a fixed light distinguished by a group of dot-dash eclipses—such as dot, dash, dot (— ——— — letter R)—which is particularly easily distinguished by its rhythmical character; and the Needles Light, which shows red over a great area of sea south of it, and when undistinguished, as at present, is liable to be inconveniently and even dangerously mistaken for a ship's port-side light, shall have a distinctive dash, dot (———— — or letter N) given to it, which, whether in its red or in its white sections, will instantly show it to be itself and no other light at sea or on shore? The five years' practical demonstration of the dot-dash system in Belfast Lough ought surely to weigh with the authorities."

Birmingham Telephone Exchange. — About three months ago attention was drawn to the fact that a Telephone Exchange was about to be established in Birmingham, and a description was given in the *Post* of the particular system which it was proposed to adopt. It is worthy of note that the system has met with considerable success in this town, several large firms of bankers, brokers, merchants, manufacturers, and others having had wires connected from their places of business with the central office of the Telephone Exchange, Exchange Chambers, New-street. As previously explained, the telephone adopted is that which has proved so successful, and is in almost universal operation in America, and is an adaptation of the invention of Mr. Alexander Bell, with improvements. The mode in which communication is established between various points is this: In each subscriber's office a transmitting and receiving instrument is fitted up, and a wire connects them with the central office. Here there is a "switch" board and operating table. The upper part of the "switch" board is traversed by twenty-four pairs of brass bars, with which the various connections are made by means of plugs, and beneath are three rows of numbered indicators for showing the calls of the various subscribers. The operating table has a transmitter and receiver fixed on it, with two rows of keys, and on a call being made, which is shown by the dropping of an indicator, the line is plugged on the switch board on to a bar that is in connection with one of the two rows of keys on the table, the depression of which key puts the line direct to the speaking apparatus thereon, so that instruction may be received as to whom the subscribers may desire to be placed in communication with. On receipt of this information, the operator plugs that line on to the other bar of the pair, calls the required subscriber, and informs him that he is in communication with the other person who has signalled. As regards the subscriber himself, all he has to do while sitting in his office is to simply press a push-button on his transmitter, which calls the attention of the operator at the central station, who immediately replies by ringing the subscriber's bell, and places his wire in communication with that of the person whom he wishes to speak by means of the switch board in the manner described. The subscriber then places the receiving telephone to his ear, and by speaking near to the transmitter fixed in his office he can carry on conversation with the person he wishes to address with the greatest ease either in the ordinary tone of voice or even in a whisper. The practical utility of this mode of communication must be apparent to every one, for by this means manufacturers, merchants, and others may instantly communicate with each other without leaving their respective establishments, and thus save both time and trouble.—*Birmingham Daily Post.*

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PRACTICAL PAPERS BY PRACTICAL MEN.

ELECTRIC BELLS.

BY W. MOSELEY.

(CONTINUED FROM PAGE 32.)

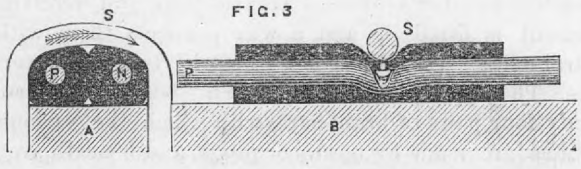
[N.B.—In consequence of delay in return of proof, the first 16 lines under this title on page 31 were printed by mistake.]

PART III.

As intimated, we must refer back to Fig. 2 for the purpose of analysing the six classes of faults that occur more or less in all Electric Bell plant, as usually fitted. We are obliged to dwell on these points for the purpose of giving good and sufficient reason for the amendments that we insist upon as being absolutely requisite. If our purpose were merely to bolster up a scientific theory by pure mathematical proof, we need only set forth a few simple equations based upon the hypotheses contained in our previous explanations of Fig. 2. But for practical purposes it would be almost as useless to the average reader as irrefutable.

In speaking of such faults as are caused by fixing wires under iron staples, it may be thought that the risk incurred, being self-evident, the mere mention of it would suffice to check the practice, but it is not so. The adoption of the practice is the result of a gradual and, in many respects, enlightened training, but a continuance of that and similar practices must be arrested by a somewhat thorough exposition, based upon a large practical experience. We have good reason for stating that the practice of fixing wires tight and neat with staples, although involving much risk as a common method, is at the same time the distinct result of great study, care, experience, and success. It is quite time, however, to show that, although up to the present time the neatest work is the best work in this, as in most other trades, yet there is no necessity for neatness to *involve* risk. At Section A, Fig. 3, we have (enlarged) a quite fair representation of the

FIG. 3



method in which nine-tenths of the wire in houses is fixed. The staple S being driven into the wall until it presses tightly upon the insulating covering of the wires P and N, the covering yields, and the wire is separated from the staple by perhaps less than the hundredth part of an inch. The longitudinal section B represents a fair average pressure, and not an accidental blow too much of the fitter's hammer. The natural result is that a lapse of about a year or two is sufficient to cause a loss or robbery of the galvanic current at nearly every one of these staples that happen to be in a damp place. The reason that little appreciable loss is detected earlier is that the covering on the wires may resist the action produced by variation of temperature and humidity for some months, but sooner or later a flaw breaks out, and a moderately damp atmosphere causes a current to flow from P to N, as indicated by the arrow. The same remarks will apply to the faults represented by C (Fig. 2). Now, in order to show how "near the wind" the electrician likes to sail when these dangers are under consideration, we need only call attention to the common practice of using a galvanometer when fixing the wires. It is known and admitted that in driving staples and in dragging wires near metal pipes, &c., there is quite a fair chance of the bare wire making accidental contact, and to settle the question the galvanometer is used.

The indication may *mean* "all right" *to the fitter using it*, but the inference may actually be as wrong as wrong can be. There are many reasons why it is a bad practice to use a galvanometer before new work is finished, and in any case for fitting or testing electric bell plant it is but an ignorant, clumsy expedient. If this appears paradoxical we cannot help it. After reiterating the statement for thirteen years, a term of continuous experience in such work, including every imaginable variety of circumstances, there must be good grounds for refusing the *assistance* of a galvanometer *(in doing new work especially)*, although it is sometimes most useful, under peculiar circumstances, to *demonstrate* certain phenomena.

For example, suppose in a building fitted with elaborate electric plant there is sufficient damp to cause great waste of the battery current. We disconnect the wire attached to the battery pole C, and attach it to one terminal of the galvanometer. Another piece of wire must be attached one end to the other terminal of galvanometer, and the other end to the battery pole C. The pointer on the dial at once flies over and settles at a certain degree on the scale. If the galvanometer is thus introduced into the circuit quickly, the pointer will remain where it first settled; but, if the circuit were broken for some minutes, it will be necessary to wait a similar length of time, so that the pointer shall stand at the degree marked on the dial that will indicate the exact amount of loss or waste of current. It must be understood by those who are not perfectly familiar with all the points in this question that, whatever point on the scale the pointer stands at, it only represents a given uncertain quantity. The loss may be spread over nearly all the wires without any appreciable influence on the action of the instruments, or it may be confined to one or two, rendering them, for the time being, completely useless. However, let us examine the wires to find out all the damp places, and, having given directions to a man to carefully pull out all the staples in certain places, we return to the galvanometer for the purpose of watching the loss gradually lessened by imperceptible degrees, but now and then a sudden jump occurs. In the latter case, we run off to the man pulling out the staples to examine the wires just released from close contact where insulation is very faulty. Having thus relieved the wires from these mischievous staples we find more has to be done, and a careful examination of the wires in various places reveals the fact that the insulating covering on the wires has been too poor to resist the damp. Let one operation suffice to explain how to detect and to remedy such faults as these represented at B Fig. 2. Having good reason to suspect that a group of wires passing through a certain wall may be quite damp or wet, we cut the main wire on the battery side of the wall, and mark the variation of the galvanometer. We attach a piece of well covered wire to the end separated from the battery wire, and from the other side pull through the new wire and replace the old portion by joining in the new. An examination of the galvanometer will show how much the waste is lessened by the operation. If the loss is reduced to a marked extent, it will be instructive to strip the old portion of wire that was inside the hole through the wall. It will be found palpably weakened at certain points by the galvanic action having dissolved the copper in the surrounding water.

A continuation of such operations will almost entirely remove the loss. So far we have in review the groups of faults represented in Fig. 2, by A, B, and C. Before referring to the various kinds of insulation that prove insufficient under the circumstances indicated, let us consider the consequences that usually follow. The waste of battery current that we have described may amount to only one-tenth of the natural force of the battery, but since this excitement of the battery to one-tenth its maximum extent is going on night and day, it is no wonder that instead of lasting more than a year without fresh charging it is almost worn out in about two months. It may be, as is frequently the case, that the question never occurs to either employer or *employé* as to whether there is undue waste through imperfect insulation, and a frequent consequence is that the battery is condemned and much time wasted. Perhaps a stronger battery is set up, with a better or worse result, according to the slight change of circumstances that so frequently upsets all calculations. Indeed, so uncertain and contradictory are the statements of experts, and ascertained facts, made to appear, that "thimble rigging" would *appear* like an exact science in comparison.

In reference to the uncertain durability of battery and wires, there are three distinct phases of the question. In one case there is frequent breakdown in the case of a new building until a year or two after completion. In another case there is complete success at first, but frequent breakdown when the building has been finished a year or two. In the third case nothing serious happens for two or three years, but then partial stoppages occur at shorter and shorter intervals, until a radical renovation is required. These three cases refer very emphatically and broadly to a choice of insulating material—india rubber v. gutta percha—and choice of battery pole—main wire on C or Z. And as the chances of such faults as represented at D, E, and F depend upon the nature of the insulation, we must here discuss the merits of the two materials so universally used.

Our first choice of india rubber was the result chiefly of a study of the "Report of the Royal Commission on Submarine Cables," forming a thick Parliamentary Bluebook.

An experience of thirteen years confirms the opinion beyond the possibility of error that for all purposes, and in all places where the wire may be sometimes dry and sometimes damp or wet, the best commercial pure rubber is perfectly reliable, whereas in all places that are sometimes dry and sometimes wet the best commercial gutta percha is absolutely worthless. With

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the assistance of Fig. 4 we will endeavour to prove this apparently rash statement.

On an enlarged scale, we have represented a longitudinal section. Through the gutta percha covering on the wires P and N the divisions in the gutta percha represent annular interstices caused by the dessication of the gutta percha. In a dry atmosphere gutta percha shrinks or contracts as it dries. Its tenacious flexible quality is dependent on some volatile property undetected on analysis. Having no fibre, it contracts equally every way, and divides itself along the wire in so many annular sections. The time occupied in the process varies according to the amount of dryness in the atmosphere. In a rarefied atmosphere charged with sulphuretted hydrogen (so frequently occurring in a large inhabited building) gutta-percha-covered wire would be full of minute interstices like those represented in Fig. 4 in less than a year, but if alternated with periods of more or less humidity the process of dessication would be proportionally delayed. We do not find any exception to this rule. The purest and rarest that can be obtained "for love or money" is only a little less rapid in its degeneracy. Let this be ascertained—and we challenge its denial—then it must be reckless ignorance alone that will tolerate the use of gutta percha insulation, except for total and constant immersion. But let us see how subterfuge and half-hearted expediency creep in.

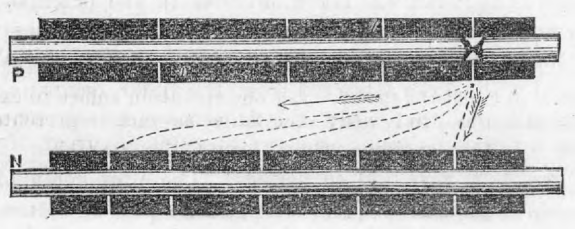

FIG. 4.

In a new building, when the wires are fixed while the walls are wet, gutta percha insulation has the advantage over india rubber, and when all is dry and the gutta percha has begun to crack, any local dampness that occasionally occurs will cause a loss of battery current and injury of the positive wire, here and there completely severing the latter; but to lighten the mischief that a single rupture would cause if the *positive* wire were the "main" wire, the main wire is attached to the *zinc* pole of the battery, so that all the line wires L as well as R in Fig. 1 are positive in relation to the main wire, which in such a case becomes the return wire. The consequence is that in any place where damp or wet conducts the current, as shown in Fig. 4, from P to N, when complete rupture takes place, it will be only *one line wire at once* that will be rendered useless until it is repaired. Such comparative respite is dearly bought; but, unfortunately, the victim knows no choice in the matter, and the day comes sooner or later when the line wires L L L L become so full of faults that total replacement becomes necessary.

Now, if india rubber—good india rubber, not poor stuff with all virtue "masticated" out of it—is the insulating material, the early period in a new building is a time of severe trial, and if the main wire is conscientiously, resolutely, made to submit to the ordeal of being attached to pole C of the battery, there may be several awkward and annoying breakdowns, but it can only be in consequence of such ignorant or careless management of details as we wish to render almost impossible, and, indeed, quite impossible, under the control of proper system and inspection, until the right method is made to become the easiest method.

Such faults as represented at D and E (Fig. 2) are supposed to occur when the wires are well covered with good insulation; but accidental injury or flaw in the covering occurring in contiguity with some good conductor, such as gas pipes, &c., or a poorly covered negative wire, the good average soundness of the main wire will actually cause a more rapid breakdown at that particular point in consequence of the whole force of the battery intensifying the action of dissolution. Such a fault as that represented by the two wires dipping into the water in vessel F. Fig. 2, is not so unlikely to occur as would at first sight appear. The practice—far too frequent—of fixing wires under floors invites the chance of such an occurrence. The wires being laid bare by rats gnawing off the covering, and an overflow of water at one of such places, is not an extraordinary coincidence to contemplate and provide against.

The common occurence of such faults as those now described as briefly as their importance will allow, has brought into requisition numerous expedients for their temporary or permanent remedy. In nearly all cases, more battery power is required to actuate the instruments than the faulty wires can long bear. In very many cases the systematic neglect of insulation of the return wire requires the use of double the battery power otherwise needed, and the consequent acceleration of ruin on the main wire. In illustration of this matter of insulation of the return wire a striking example of the obtuseness to such a necessity occurred in the treatment of the wires of the Palace Hotel at Southport. After seven years of almost constant trouble and expense, we were requested to apply some radical remedy. The case was a very peculiar one, and the remedy consisted of little else but thorough insulation of the return wire as represented by R, Fig. 1, resulting in immediate and permanent removal of the mischief.

That such blunders have occurred, and are frequently happening, will not be so much wondered at when it is pointed out that electricians who write with authority, and can have all their own way on paper, commit blunders equally egregious. For in reference to the question as to *whether the main wire should be attached to the positive or negative pole of the battery*, Mr. Sprague says, "it does not matter which;" and another writer, who addresses himself elaborately to the fitting up of electric bells, gives precise instructions about attaching the main wire to the positive pole ("copper"), also explains in detail how to test the insulation of the line wires, but not a word of advice or caution about the insulation of the main wire.

Nothing could be more conclusive, as regards the necessity for a thorough exposure of the many bad practices adopted in fitting up electric bell apparatus, than the fact that carefully detailed instructions are printed and widely circulated, in which matters of indifferent moment are strongly emphasised and those of critical importance entirely ignored. To withhold information might be justifiable policy, but to publish deceptive information can only be excused by ignorance. The necessary corrective we wish to make as clear and final as possible.

Within the last ten years a valuable experimental school has been opened (or *re-opened*), where many plausible schemes and dodges have been tried and found wanting. We refer to the use of electric bells and signals on board ship. Any method or system that will stand the test of a few years use on board ship will stand anywhere. The *ordinary* wire insulation, method of fixing contactors, indicators, bells, all are frail and futile for use across the Atlantic. This has been proved on twenty-three of the largest Atlantic steamers. We have fitted up, or re-fitted, twenty of these, and it should be a useful guide to explain the beginning and the present result in the case of the now celebrated fleet of White Star steamers, as being the most extensive illustration under one ownership as well as the first thoroughly successful experiment of the kind on board ship.

A letter from the builders is now before us, dated January, 1870, declining to let our warning prevent the trial of similar fittings to those used so successfully in houses. In spite of great precaution, our worst fears were exceeded, and frequent trouble ensued. In 1873 we invented and patented a complete system, and refitted those previously done, as well as the other new ships, ending with the Germanic. On the conclusion of the business, we recommended that a certain ship joiner in the builders' employ should be added to the "shore gang," to have entire charge of the electric apparatus on the eight steamers. From that time to the present all wear and tear and new work required by alterations of rooms, &c., has been done by him without assistance, and without any instruction whatever, beyond that received in assisting when the ships were first done. A fault in the main wire is never met with, hence the interruption of several contactors or lines at once never occurs. The inference must be irresistible that if such permanency can be so surely secured on shipboard it would be absurd to doubt its practicability on shore indoors. The exposure of wire and contactors to salt water anywhere on board ship is inevitable. The ordeal of frequent intermittent contact with salt water is severe beyond all previous calculation. The manner in which the difficulties are easily overcome shall be now explained; the translation of the principle to the circumstances of houses, &c., will then be better understood, and we trust its importance will not be underrated. Meanwhile, it will be of the greatest service for all who are practically interested in the question to set up and set apart for a lengthened series of experiments the apparatus described in Fig. 2 substituting a galvanometer for the bell. For such a purpose an ordinary electro-magnet bobbin may be extemporised to repel a light steel magnet made by magnetising a large sewing needle and suspending it by fine silk thread exactly perpendicular to the edge of one end of the bobbin of wire (no iron core must be used). The wires between battery and vessel F should be free from all possible contact, so that all galvanic action outside the metallic circuit may be confined to the water in F. By charging the latter with sea water, everything that *can possibly* occur on board ship may be made to exhibit itself (or its conduct) at your command.

(TO BE CONTINUED.)

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TELEGRAPH CLERKS, PAST AND PRESENT.

The acquisition of the Telegraphs by the State, now some nine years ago, not only inaugurated a new era for telegraph clerks, it, so to speak, created a new race of them. A vast number, far exceeding what had ever been estimated, were found necessary to work the system under the new regulations; and continually increasing traffic has demanded a corresponding growth of the staff. These are all quite young men; they have been taken into the service at the age of from fourteen to sixteen, and they have still therefore a long future to look forward to. Fortunately for them, they began their career under the new administration, and will fit into, or adapt themselves to it with a cheerfulness which no regretful recollections of the past will mar.

The life of the telegraph clerk was not always what it is now; and for those who have tasted the experience of its earlier and its later phases the contrast is not altogether pleasing. Few however can make this comparison, and happily they grow fewer every day. True a great number of clerks were "acquired" with the other belongings of the old companies; but by this time they have for the most part, we hope and believe, risen from the rank of clerk to that of superintendents, or at all events to positions where the difference between their old life and their new to which we are now referring is not so painfully marked. It may be interesting to recall what that old life was, and to note the change which has been wrought in the telegraph clerk's duties and prospects by the public determining to have their telegrams sent for a shilling instead of for a sum that was generally greater and always rather uncertain.

The first great Company for transmitting despatches by electric telegraph was incorporated in 1846; and it was during the ten or fifteen years following that the major portion of the staff was taken on, both in the original company and in other companies which then and later on sprung into competitive existence. These rival ventures were largely manned with clerks attracted from the older company; and the result was that when the Government took over the whole of the systems they found the *employés* young in years but very old in service. The proportion of old servants was indeed quite surprising; and it seemed the more so considering the long hours and small salaries common to all the companies alike. There was evidently some attraction to, or fascination in, the employment which long hours did not outweigh, nor small pay diminish. "Once a telegraph clerk always a telegraph clerk" was plainly the rule up to 1870; and whether it was that he became unfitted for any other calling, or that he felt no inclination to try, he seldom broke loose from the first profession of his choice. He joined it very young indeed, often in his thirteenth or fourteenth year. The pay was not bad to begin with, and youth is not given to looking far ahead. Regrets perhaps came in after years; but they came too late. Meanwhile he had a pleasant occupation and an easy time of it. If his hours were long his duties were light; and in any case he held a position which was, in those days, something unique and flattering to his pride. The telegraph clerk was *somebody*, compared with whom the booking clerk at the Railway station, and the young man behind the counter of the town Post office were ridiculously commonplace. No mystery surrounded their avocations, no magic dwelt in their fingers, and wonderment never followed their footsteps. All this was reserved for the lad who worked the telegraph wires. Hardly anybody knew how it was done; and the favoured few who were now and again admitted to the sanctum of unfamiliar appliances departed with the conviction that he who could shape words from those fluttering needles truly must have been born to it. His skill was indeed remarkable, and it grew as he grew. Both for speed and dexterity the feats he performed in those primitive times are not excelled, if they are equalled, by anything done in these.

One reason for his quickness was perhaps the intermittent character of his work;—it did not come in quantities to tire him. Messages were things he had to look out for; when they appeared he turned to them with freshness and alacrity, and not with that deliberateness which comes of husbanding strength for one long continuous effort. He had plenty of leisure, and here was another of the charms of his calling. If he was studious, he could follow his bent in almost any direction he pleased: and if he was playfully inclined he could, it must be owned, humour himself in that way too.

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Check sheets did not exist in those days, and a little delay, more or less, was comfortably accounted for by a friendly arrangement of M.Q.s. A hand in a game at cricket was not an impossible luxury, and skating was irresistible. At night he read until he fell asleep; and learned to sleep so cunningly that nothing would wake him but the tick of the needle, which brought him to his senses instantly. They were long weary hours for him, and his little constitution must have been permanently impaired by want of rest, irregular meals, smoking cheap tobacco, and reading in unwholesome atmosphere. But he endured it patiently; and when he at length got wearied out, he could always obtain a change, if only from fire to fryingpan, by seeking removal to another station. This was a great feature with the old companies; the establishments were not large, and promotions were commonly effected by tranfers. The telegraph clerk seldom stayed more than two or three years in a place,—some large centre, the metropolis by preference, being looked forward to as his final destination for settling down.

His pay was as uncertain as his whereabouts; he was innocent of increments; he had to wait a long time for his "rise," but when it came it was well worth having; and perhaps this chronic state of expectancy had something to do with reconciling him to his then hard lot, and very ambiguous future. As years rolled on, he became disenchanted, and all the ease in the world would not supply the wants of his maturity, much less keep his wife and family. From the first pressure of this discovery the companies were relieved by the projection of cable telegraphy. The more restless spirits, the more discontented, the more enterprising, promptly enlisted themselves in this more remunerative branch of their calling, and many who were once the out-at-elbowed hangers on of the Home telegraphs are now enjoying comfortable and well-to-do quarters in far off corners of all the civilised world. Then there came the prospect and finally the accomplishment of the whole systems, clerks and all, being handed over to the Government. But for this, the employers of the old telegraph clerk must have opened their purse-strings, if not their hearts, very speedily. As it is, his patience has been rewarded; he has a comfortable competency compared with which his past was absolute penury; and his future is well provided for. His work is heavier and responsibilities greater; but, in respect to those pleasant reminiscences which we have been recalling, the change has not fallen very heavily upon him.

With the present race of telegraph clerks the case is perhaps different. True they have no rosy period of ease and recreation to look back upon; but on the other hand there is not much delusive uncertainty about their future. They can reckon with tolerable certainty how many increments they will have had by the time they have reached any given period of their lives. Moreover there are not now so many outlets for the aggrieved operator. We call him "operator," for we believe he is no longer esteemed a "clerk." There is not much in a name, but this one marks a great revolution. The telegraph clerk of to-day, we are told, operates from morn till eve, from eve till dewy morn, with neither break nor interruption. The flow of traffic is relentless, oppressive, unending; and when his spell of duty begins he knows that his hand will be kept going till the allotted hours are spent. But on the oher side he has many advantages unknown to his predecessors. His hours are fewer, his pay far better; his night duty not so ruinous to health. We are not quite sure about his provision for old age; but during sickness he is liberally cared for. As to his leisure, if he has not so much of it, it is more enjoyable when it comes. "Off duty" must be to him a welcome signal for recreation such as was formerly little understood or appreciated. A few words about this spare time may not here be out of place.

With the increase of traffic there has been a proportionate enlargement of establishments; and the number of clerks now upon each is generally sufficient for useful coöperation of some kind. Book clubs, cricket clubs, reading societies, classes for study, meetings for amusement, to say nothing of those combinations for saving and purchasing, nowadays so common, are all open to the telegraph clerk of to-day. He is young at present, but he has a future to encounter and to provide for; and now is the time to begin. He has entered upon a calling which is honourable, respectable, fairly remunerative, and exceptionally secure. While accepting its advantages, therefore, he should boldly face its inevitable drawbacks. He will not rove about as did the more isolated clerk of the past; he should therefore seek to make his fixed abode as comfortable as may be. We feel sure that it only requires that they realise the future before them to induce the whole of the clerks, at least in each particular town, to unite for purposes such as we have hinted at; and we are confident also that any efforts in these directions, initiated by them, will be seconded by their superior officers. The clerks at cable stations have done this much long ago; and their employers have wisely as well as humanely encouraged them. We should be glad to hear of similar measures being adopted at home.

In any case, whether thoughtless or prudent, extravagant or thrifty, far away or near at hand, they have all our hearty good wishes. We hope they have spent a Merry Christmas, and we now wish them a Happy New Year.

THE TOMMASI ELECTRICAL INVENTIONS.

We translate the following from the *Revue Industrielle*:—

We have received from a certain number of our subscribers requests for information on the subject of an enterprise which, under the title of The Tommasi Universal Electrical Society, appeals to the public to find a capital fixed at the sum of two million francs.

Since the great success of the Jablochkoff Company, inventions relating to electricity have had the effect of peculiarly exciting the appetite of promoters of joint stock companies; and capital, by responding to demands addressed to it, has sometimes justified their audacity. It is good, however, to observe a degree of moderation in the most hazardous enterprises. The conditions under which the Tommasi Electrical Company comes forward are so interesting that we shall devote several columns to their consideration.

If we are to believe a prospectus, printed on the fourth page of a finanical journal, started expressly to deal with such matters, the above-mentioned Company proposes to manufacture and offer for sale *urbi et orbi* all the electrical instruments patented by M. de Tommasi, and especially the Tommasi lamp which allows of the use of the electric light for domestic purposes, as well as all the different patents taken out by M. de Tommasi applying to the arts, to industry, and to medicine, &c. It is, in fact, a conversion into shares of the inventive genius of M. de Tommasi, who binds himself by the agreement to surrender to the new Company the entire benefit of all his inventions having relation to electricity, including even those which he may make in the future.

We have no intention of discussing the value of this last moral support; we cannot help recalling a certain proverb about the bear and his skin; but, still, we know M. de Tommasi to be an indefatigable if not a very successful worker. We shall content ourselves with analysing the matter as it presents itself at present, discussing that which exists, and is under our eyes. The circular of the Universal Company in formation will be our guide in this study.

The new inventions of M. de Tommasi may be reduced for the time to the *universal battery* and the *electric lamp*.

It is expedient first to give the reader some idea of these, and

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with this view we do not think we can do better than to reproduce the descriptions given by the official journal of the Company.

"The battery of M. de Tommasi is composed of the same elements as the ordinary Bunsen, but modified and arranged in a different form and manner. All the outer jars are double the usual height, and communicate with one another by means of continuously-acting syphons, which ensure the constant renewal of the acidulated liquid, and the suspension of its flow when not in use. The zincs are then dry, and are not wasted. These syphons are closed by simply pressing an india rubber ball placed at the top part.

"The inner jars, likewise cylindrical, are porous only in the upper part, the lower half being glazed. Closed by porcelain stoppers or covers, well fitted, these jars contain in the lower part the nitric acid, which is thus enclosed in a regular bottle, since it can neither escape by the pores of the carbon nor by evaporation from the top. To the cover is fastened a combination of plates made from gas-carbon, these being only as long as the porous half of the inner jar, into which they fit closely, occupying one half of the capacity of this porous portion. The other half of this capacity is occupied by a block of porcelain of the same shape as the carbons, and of such form as to occupy with the latter the whole upper or porous half of the jar.

"This block is sustained by an aluminium wire, unattacked by nitric acid, and passes through the porcelain cover. If this wire be lowered, the block descends and occupies half the lower and non-porous part of the jar, expelling an equal bulk of acid, which, rising into the porous half, comes into contact with the carbons. On the other hand, since in a battery, the useful chemical action takes place only on that part of the zinc which faces the porous surface of the jar, it was useless that the zinc element should extend to the bottom of the outer vessel. It is, therefore, made to reach only to the depth of the porous half, by means of a narrowing of the jar produced in its manufacture.

"Moreover, in order that the zinc may be attacked only upon its inner surface, the outer surface is covered by chemical action with a coating which fastens the zinc to the sides of the outer vessel. Lastly, the zinc has at the top a groove filled with mercury, intended to keep up the amalgamation."

The Tommasi lamp which has had the honour of presentation to the public is adorned with the sonorous title of the Revolver-electric lamp.

The Journal of the Company speaks of it in these terms:—

"The Revolver lamp, which will give light for 18 hours, is enclosed in an outer casing, which may be more or less rich and more or lese artistic in form according to the taste of the purchaser. If we remove this covering, the apparatus presents itself in all its simplicity. We remark at the first glance six tubes fixed on a box of copper, and converging towards the top of the lamp. Each tube contains a rod of carbon thirty centims. long, and from one to three millims. in diameter, according to the intensity of the light required, projecting from the top of the tubes, into which they are pushed from the bottom. At the top these carbons press against a block of carbon attached to a central rod in permanent communication with one of the poles of the source, whilst the tubes are alternately in contact with the other. To eliminate the shadows produced by this rod, M. Tommasi has had the happy idea of combining a lamp with double focus, in which he burns simultaneously two carbons, one in front of the other; in this way the total consumption of carbon is divided into two parts without additional expense, and a focus is obtained radiating equally on all sides a white light of irreproachable steadiness, but the intensity of which may be always varied according to the pleasure of its possessor.

"In the body of the apparatus is a clockwork movement which turns a hand sliding against a commutator placed in front of the lamp. The dial of this commutator is divided into six sectors, so that, when a carbon is consumed, the current can pass to the next X stick without interruption, and, above all, without the least irregularity, the mechanism constantly moving on the hand which every two hours produces this invisible substitution."

After having thus, with all impartiality, given the necessary descriptions, we will proceed to get a little nearer the question, and see in what the novelty of the Tommasi inventions really consists.

The universal battery is, after all, only a Bunsen; more complicated in construction, it is true, than those usually found in use.

Before we pronounce upon the merit of the arrangements introduced, we should desire that this cell should be placed in other hands than those of the inventor or of his associates. In the absence of disinterested information, we must content ourselves with the accounts given by the circular appended to the prospectus of the Society, in which we shall find some food for reflection.

The employment of the pile as a generator of electricity is already condemned by everybody who has seriously considered the question. The *Revue Industrielle* has recently published an article on this subject, an article the more worthy of consideration inasmuch as the author, after having tried to make use of batteries for small lights, has come to the conclusion that it is not possible to count upon this method for the practical production of electricity.

Since then, M. Hospitalier, in a paper on the maximum work obtainable from batteries, has completely discussed the problem, and has come to the same conclusion. In comparison with machines, batteries are inapplicable as sources of electricity, whether electric light or motive power requires to be obtained.

The editor of the documents put forward by the Tommasi *Société universelle d'electricité* does not, in the prospectus signed by him, appear to be aware of this fact. If we are to believe him, the universal battery is calculated to replace, within a brief period, not only the ordinary Bunsen battery, but also the magneto-electric or dynamo-electric machines, and the demonstration put before us is far from satisfactory. With regard to Bunsen's elements, he reproduces the results of experiments made in 1857 at Lyons by Messrs. Lacassagne and Thiers, and comes to the conclusion, without taking into account the consumption of carbon and the cost of maintenance, that the cost of the light per hour for one regulator would be 2fr·94.

The judgment passed against machines is supported by figures of an extremely questionable nature, as will be seen.

1st. The intensity of the light obtained from one machine is placed at 100 or 120 becs for three horse-power. The following table shows that this estimation is positively incorrect:—

RESULTS OBTAINED WITH DIFFERENT MAGNETO-ELECTRIC MACHINES:—

Machines	Number of becs*	Total force in kilogmètres†	Number of becs per horse-power
Wallace (small)	118	292	30
Brush (small)	242	282	64
Holmes	217	240	67
Alliance	279	270	77
Brush (large)	332	244	100
Gramme (1873, small)	190	138	103
Gramme (large)	573	397	108
Siemens (large)	1,276	735	130
Siemens (medium)	591	247	179
Gramme (usual size)	590	192	231

* 1 Bec = 10 stand.-candles.
† 1 Kilogmètre = 7·2327 ft.-lbs.

2nd. With these machines, he says, seven lights (incandescence) of from eight to ten becs each, may be obtained. Here, again, is another error; not seven, but ten, and even twelve should be here read; for as many as nineteen incandescence lamps, each giving from five to six becs, have been placed in circuit with a Gramme machine of the usual type, driven by an Otto and Langen gas machine, and the experiment is easy to repeat.

The first cost of the Tommasi battery appears to us to be unusually low. Whatever the arrangements of the inventor, they would not influence in any way the chemical reactions necessary for the production of the current. The phenomena are the same as in an ordinary Bunsen element, and we cannot see how the use of siphons could reduce the expense from 1fr·45 to three centimes per hour.

Moreover, if anyone were to give himself the trouble of calculating the duty of the universal cell, taking for his base the amount of zinc consumed, he would arrive at the astonishing result that sixteen cells burn about twenty times less zinc than ought theoretically to produce the intensity of 15 becs attributed to the light. The remaining figures as to consumption are forthcoming, and it is scarcely necessary to add that the cost price is, in our opinion, considerably higher than that stated in the prospectus.

Without going further into this point, we do not think that magneto-electric machines have anything to fear from the universal pile.

If the Tommasi cell does not offer a practical solution of the electric light question, it, at all events, possesses several new details. We cannot say as much for the lamp, which is purely and simply a reproduction of the arrangements invented during the year by M. Reynier. The mercury lamp and the revolving lamp are only imitations of different models specified in the patent of this inventor. The consumption of the end, and the progressive renewal of the carbon rod, the lateral contact intended to limit the incandescent part, are reproduced, always with this difference, that M. Reynier has, by dint of study, given to his apparatus certain practical qualities in which the revolving lamp which we have seen at work is absolutely deficient.

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The use of mercury with an incandescence lamp is altogether out of the question on account of the heat and unavoidable distillation of the metal. With regard to the revolving system, it throws such shadows that to diminish their effect it becomes necessary to double the lights. Here, then, is one cause of inferiority, such that there is no need to look for another.

In short, where is the electrician who would seriously admit of a consumption of 5 centimètres of carbon per hour in pencils such as those with which the revolving lamp is supplied?

Even with 5 centimètres per hour one does not obtain 15 becs, nor even one bec; but nothing more than a night-light; and the lighting of sick chambers is the only rational use to which so poor a light can be applied.

It appears from the prospectus issued by the Tommasi Universal Electrical Company that people whose name has authority, members of the Institute, electricians, savants, have, after examination, forwarded their high appreciation of the above discoveries.

We should not have been sorry to have had upon this matter the opinions of the masters of science, or, at least, of some competent electricians; but the members of the institute have, doubtless, reserved their prose for a better occasion, and we are compelled to fall back upon the reports of M. l'Abbé Moigno and M. Paul Giffard.

We are always disposed to render homage to the talent of the Abbé Moigno, at the same time we do not consider him *one of the greatest savants in the entire world* (style of the prospectus). We know that he is goodness itself to inventors, that he hears them with the most christian indulgence, and that he has the secret of saying to them that which they best like to hear. All who have had anything to do with the director of the *Cosmos* have preserved the kindliest recollection of him without, at the same time, ever having taken his opinions for gospel. Also, when the Abbé Moigno, Canon of Saint-Denis, Chevalier of the Legion of Honour, allows his name to figure at the head of the council of patronage and foundation of the society, it is in the capacity of adviser and supporter.

An appreciation of the affair from an industrial point of view is not required of him; the Abbé Moigno thinks of his poor. Leave him to his works of charity.

M. Paul Giffard, who must not be confounded with M. Henri Giffard, the engineer, who has so justly established his reputation by the invention of the injector, by the studies upon the direction of ærostats and the creation of the captive balloon of the Exhibition of 1878, M. Paul Giffard, we say, is already known by several mechanical works, and especially by a segmental piston in caoutchouc and a machine for making ice.

Not much electrical knowledge, perhaps, is required in these researches; but that would not add anything to the value of his opinion when he declares that the apparatus of M. de Tommasi gives "the complete solution of the great question of the division of the electric light, of the domestic light in one word."

It only remains for us to add one sentence, and to close this article.

According to the editor of the prospectus of the company, the cost price of a battery of six Tommasi cells is thirteen centimes per hour, everything included, for a luminous intensity of 15 *becs*; according to M. Paul Giffard, a battery composed of 20 Tommasi elements consumes 10 centimes per hour, furnishing a light of 10 becs.

By similar discrepancies between the opinions of the only two authorities whose reports are published, we are thrown into the greatest perplexity. After all, perhaps, the inventor has only proposed to solve the following problem: to find a pile which produces less light when the number of elements is increased.

PH. DELAHAYE.

LITERATURE.

International Telegraph Convention with London: Revision of Service Regulations and Tariffs, 1879. Translated by Alfred Brasher. Copies to be obtained of the translator, 55, Parliament-street.

This work consists, in the first place, of the international service regulations annexed to the Telegraph Convention of St. Petersburg, and revised at London. Each page is printed with two columns, one containing the text in French, whilst the translation occupies the other. This part is followed by tables of tariffs relating—1. To the European system; 2. To the extra European system. The work is very well done. We have not found any errors in those portions we have examined. The printing is clear, and the type is large. The value of such work as this depends, of course, upon its accuracy, and this the author may fairly claim.

CORRESPONDENCE.

THE SIGNALLING SYSTEM IN NEW ZEALAND.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Can you or any of your valued correspondents give me the signals of the telegraphic alphabet and figures used in New Zealand Government telegraphs; also the manner in which messages are signalled—if it differs from that used in England.—Yours, &c.,

A. M'C.

CANTOR LECTURES.*

RECENT ADVANCES IN TELEGRAPHY.

By W. H. PREECE, Electrician to the General Post Office.

LECTURE V. (CONCLUDED.)—DELIVERED MAY 19.

The principle of the transmitter is nearly identical in all kinds. There is an ebonite working lever, in which two brass pins are inserted. One of these pins is connected by a fine wire to the line, and another is similarly connected with the earth. This lever rocks with a backward and forward motion with tremendous velocity, and as it rocks it causes the two rods (one marked A and the other marked B) to move up and down in the same way with the velocity of the ebonite lever. Also there are two crank levers, one attached to the zinc of the battery, and the other attached to the copper of the battery, which are pressed towards each other by springs (C and D). The rods A and B, that work vertically up and down, are also attached to similar levers, and are pulled by two springs, which always cause them to tend upwards. As the lever rocks, these two rods move up and down, and so long as the paper, E, passes over them without any perforation or hole in it, so the rocking harmlessly continues, that is, it causes no current whatever to flow to line; but if immediately over the needle, B, a hole be placed, then that needle in its upward motion passes through the hole, and causes the copper pole of the battery to go to line; the zinc pole of the battery being connected to each, and a current is transmitted to the distant station. That is the case when the top hole is punched. If the bottom hole be the one punched, then needle A passes through it, and in doing so (the reverse of what I have just explained takes place), a zinc current goes to line, and a copper to earth. So that we see when the needle B passes through the top hole a copper current goes to line, and when needle A passes through the bottom hole a zinc current goes to line. These currents are momentary, and whenever they pass, a dot or dash is simply made by the rate at which one current follows the other. If first of all a positive current be sent, and then a negative current immediately after it, we have a dot; if we send a positive and that is followed by a blank, then by another blank, and then by a negative current, we have a dash; so that the difference between a dot and dash is due to the loss of a current. If all the holes were punched without a space you would have a succession of rapid reversals sent to line—positive, negative; positive, negative; and so on, one repeated after the other. The reversals in this system are not made in the same way as I have explained to you in other apparatuses, by the duration of the current itself, but they are made really by pauses and the practical absence of current. The way in which this reversal works will be more evident to you when I explain the receiver; for the present I only want you to notice that the first part of the dot is produced by a positive current, the last by a negative current following immediately. The first portion of the dash is made by a positive current, then a hiatus, followed by a negative current (positive, negative the same as before), and the result is that by sending the paper through, punched in this way, we regulate the rate at which the rocking lever, or rather we do not regulate the rocking lever, for that goes at a constant speed; but we regulate the number of times that the needles pass through their holes, and so regulate the formation of dots and dashes at the distant station. By this means we are able to send dots and dashes with marvellous rapidity. We will now put a slip through this other transmitter. That slip is going through at the rate of 140 words a minute. One slip can be used almost any number of times. The punched paper, as it passes through the transmitter, causes the little vibrating rods to select their proper holes, and to regulate the positive and negative currents as they pass to line. The positive current acts upon what is practically a relay, and causes the tongue of that relay to move over to one side. The negative current immediately following causes the tongue to go back to the other side. A dot is made by a rapid reversal; a dash is made by two reversals, the middle one being missed. This action is shown by the diagrams, but will be more clear to you when you see the instrument actually at work. The positive and negative currents having passed through the transmitter to line arrive at the distant station, and act upon the receiver. The receiver is really nothing more nor less than an extremely delicate form of ink-writer, based on the Morse principle, and is so constructed that it records the message at considerable velocity. There are two things necessary to make a receiver of this kind work well. The first is that, running at the very high speed requisite to receive the signals with such velocity, the mechanism must be so perfect that it shall not lose its regularity, but run in accordance with the rate at which the messages arrive. Secondly, the mechanism must be supplied with a governor, and a very great amount of ingenuity has been displayed in the formation of governors to those delicate machines. Attached to this receiver we have a governor, that can regulate the speed from about 20 to 200 words a minute. The ordinary forms of receivers only go to 130 words a minute, but the necessity of the age and growth of business have compelled us to look ahead a little, and now we have instruments constructed so that they can be regulated up to a speed of 200 words a minute. Again, the action of the receiver depends essentially upon the electro-magnetic

* From the *Journal of the Society of Arts* for November, 1879.

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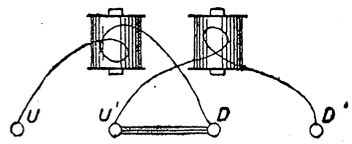
part of the apparatus. I have mentioned once or twice that one of the chief difficulties we have to contend with in telegraphs is due to the existence of a disturbance on the line, called electrostatic induction, which is, as I mentioned to you, something like friction in pipes. It retards the currents, and causes the positive and negative currents sent with great rapidity to run into each other and to record their marks slowly. The speed at which the instruments receive the messages is governed a great deal by the resistance opposed to the passage of the currents. The greater the resistance the less the strength of current flowing, and the slower the rate at which the instrument works. But there is a very curious cause of retardation or disturbance of these instruments, due to what is called the electro-magnetic inertia of the electro-magnet itself. Whenever a current is sent round an electro-magnet, another current is set up in that electro-magnet in the opposite direction, and this "extra" current, as Faraday calls it (it is one of Faraday's greatest discoveries), opposes the strength of the first current, and, therefore, produces retardation. So that, in the working of these fast speed apparatus, we have to overcome resistance, electrostatic induction, and electro-magnetic inertia. These are points that have been attacked, within the last few years, by the officers of the Postal Telegraph Department, with a great amount of zeal and ingenuity, and one by one they have been mastered until now, instead of being able to work only at the rate of 45 words a minute on the Morse, we can work, say 150 words a minute, which is practically as fast as we want to work anywhere. In 1876, for instance, the rate at which one of the best wires in the country was worked was 120 words a minute—that is, to Manchester. To Sunderland the rate was 90, to Aberdeen the rate was 60, to Dublin the rate was only 40, and to Cork (one of the longest circuits we have) the rate of working by this automatic apparatus was then only 38 words a minute. By removing the disturbances I have mentioned we are now able to work to every one of these stations as fast as the apparatus will run, and to Cork (I took the trouble this morning to find out the rate) we are working daily at the rate of 130 words a minute. That is simply the rate at which the instrument works, and not the rate at which it can work; and if apparatus of the newest pattern be used, and if there be a necessity (which, probably, there will be in a year or two) to increase the rate of working, I have no doubt we shall work to Cork at the rate of 200 words a minute. Now the amount of business does not require a greater speed than we are working at, and from 1,000 to 1,200 messages are transmitted daily between London and Cork through a wire fitted with this automatic apparatus. The rate of working to Aberdeen is another instance of fast speed transmission. The wire from London to Aberdeen is 600 miles long, and over this wire we can work as fast as the instrument can run. The progress in this direction that has been made by the Postal Telegraph Department is best shown by this, that while, in 1876, the average rate at which our Wheatstone instrument circuits worked was only seventy words a minute, the average present rate of such working is about 130 words a minute. This improvement has been brought about by attacking the causes of obstruction I have mentioned. The magnets have been shortened, the mass of iron to be magnetised has been reduced, and the resistance lowered. These alterations have been principally carried out first of all by Mr. Lumsden, next by Mr. Marson, and latterly by Mr. Chapman, all officers of the Postal Telegraph Department.

I have great pleasure in showing you how one of the greatest of these improvements has been effected; it is not patented, and I have no doubt that in other applications of electricity the idea may be useful. It is this.

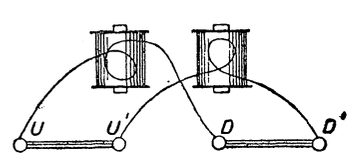
Here is a diagram, supposed to represent two cores of an electro-magnet (Fig. 12). Generally the wire of an electro-magnet passes round it a great



SINGLE WOUND SERIES

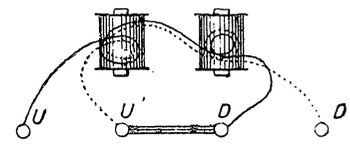
many times, but in the diagram one spiral only is shown. In this diagram the wire shows the manner in which a magnet is ordinarily wound, and is said to be wound in series, the current entering at the left and passing out at the right. In a magnet so wound we have what is called an extra current, and this extra current as I have described to you produces retardation.

The first improvement in this magnet was effected by joining the electro-magnet up in what is called "quantity" (Fig. 13). The current in passing



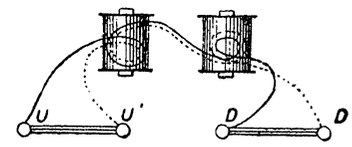
SINGLE WOUND QUANTITY

through an electro-magnet so joined up divides itself, one-half going through the right coil and the other half going through the left coil, and the first effect of this was to reduce the resistance of the coil. But it had another and curious effect, and that was that the extra current in the left leg met the extra current in the right leg, and they neutralised each other, and this removal of the extra current considerably expedited the working speed of the electro-magnet. The next improvement was that as duplex telegraphy became introduced all our apparatus, whether worked as duplex or not, were wound "differentially," as it is called, so as to be available for duplex working at any time; and the coils shown by this diagram (Fig. 14), are supposed to represent a magnet, such as we have on the receiver before you, and are wound differentially. A current starting from U passes through the whole course of the wire and meets all the resistance of the circuit before it arrives at D^1. To reduce this resistance, the coils, as I have said,



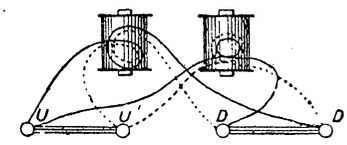
DOUBLE WOUND SERIES

are joined up in quantity (Fig. 15). [Course of current through quantity arrangement described.] The quantity arrangement reduces the resistance



DOUBLE WOUND QUANTITY

by three-fourths. But lately we have joined the coils up in "double quantity," as it is called, as shown in diagram (Fig. 16).



DOUBLE WOUND DOUBLE QUANTITY

[Course of current through double quantity arrangement described].

The "double quantity" not only reduces the resistance still further, but the extra currents in each coil are completely neutralised by the extra currents in the other coil, and they are entirely prevented from producing a retarding effect. Many other means of improvement, such as shunts, condensers, strong batteries of low resistance, and high electromotive force, and others that I have not time to allude to, have been employed, with the result that we have attained this great accession of speed. But a great accession of speed has also been obtained by another and quite different manner. Take, for instance, a wire from London to Cork. The first portion of the wire extends on poles from London to Haverfordwest, about 300 miles; from near Haverfordwest (Abermawr) to Wexford it passes through a cable, about 80 miles; and from Wexford to Cork we have about 100 miles on open poles. The principal cause of delay in working this wire is the existence of a cable in the middle of its path, just at the point where it opposes to the working of the circuit the maximum amount of electrostatic induction. The rate at which such a circuit works is governed by the speed at which its cable section works. It is quite possible to make an open-air line between London and Haverfordwest work a great deal faster than the cable between Haverfordwest and Wexford. The addition of cables to open lines is simply to retard the working, and we find that if it were possible to introduce at the end of the cable a translator, or relay, which would bring into play fresh currents, the speed of working would be very much increased. This was tried, and we found that while the wire had only been working at the rate of about 40 words a minute previously, when a relay was put in at Haverfordwest, the speed at once jumped to something like 100 words per minute, and the success of this mode of working was so satisfactory that a relay was speedily placed on the London-Jersey circuit, the speed of which was at once improved from about 50 to 80 words a minute, and so on. The success of inserting fast speed translators in the middle of our lines has become so great and so evident, that at the present moment, we have no less than 50 of these translators fixed in different parts of the country; and these have aided materially in producing the great accession of speed I mentioned just now. For instance, between London and Aberdeen we have a translator fixed at Newcastle. Without that translator the wire would not work at a greater speed, probably, than 80 words a minute, but with it we get 140. Again, between London and Dublin, we have established a relay station in Anglesea, and the result has been to make the rate at which we work to Dublin practically unlimited. And of all the improvements that have been introduced into the postal telegraph service, there, perhaps, is none more important than that of introducing these translator-relays. The amount of business transacted by these long circuits is something fabulous. There is not a single town in this country which possesses a daily paper that has not direct communication with London by means of these wires; and every morning at the breakfast table, everybody, wherever he may be, is able to get the whole news of the country, which has been transmitted by means of these wires. In fact, the news system is quite a system of its own. A wire running to the West supplies news to Bristol, Exeter, Plymouth, Gloucester, Newport, and Cardiff, and all those six towns receive simultaneously, on Wheatstone receivers, news that is punched on one slip in London. It is only necessary to punch one slip, which can be run through a transmitter on one wire, and supply all the towns on that wire that receive the same news, and can then be run through another transmitter, and supply other towns to which the same news is furnished; so that thirty or forty, or almost any number of towns, can, by this means, be supplied from one slip.

The limit of working has not yet been reached. It is quite possible (though the necessity for it has not yet arisen) to duplex this Wheatstone automatic apparatus. I do not say that, in duplexing, we shall be able to secure on these long circuits double the speed; but there is no doubt that, in duplexing, we shall very much increase the capacity of the wire. At the

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present moment we do not want to send more than 150 words a minute, but I have not the least doubt that, when the time comes, with our present apparatus and our present knowledge, we shall be able to transmit, at least, 300 words a minute.

There are in the country, now working, 250 of these transmitters, and 370 receivers; they are all worked at very high speed.

I think I have said enough to show you that the improvements that have been effected, have simply arisen from the necessity of the day. Requirement always brings forth the exertion of zeal, thought, and experience, and all the improvements that have been made, especially those instanced in the apparatus now before you, are the result of this experience.

While the ancients devoted their time principally to questions of philosophy and art, the men of the present day—the moderns—devote their time principally to questions of industry and the application of mechanics to the wants and purposes of man. The growth of all telegraphic apparatus has been growth by evolution. The apparatus which you see before you is in reality the survival of the fittest. We commenced by using the very crude instruments which I described to you in previous lectures—the double and single needles; we have now come to the employment of perhaps the most delicate piece of mechanism to be found in any trade. I do not think I am wrong in saying that in no art will you find more beautiful, carefully constructed, or elegantly designed mechanism employed than in the instrument before you; and for its production I can tell you that we are chiefly indebted to that prince of mechanicians, Mr. Stroh. All the improvements, as I told you, have been the result of experience, patience, and trial, and if you could only see the patience with which some of our electricians of the Post Office work out these trifles, you would be surprised that there are men who devote their time in such a way. But this process is always going on; it is constant and incessant, and improvement keeps pace with the requirements of the day.

There has rarely arisen a necessity of any kind, but that somebody has stepped forward to meet it, and when we hear people say that invention has left the shores of England and gone to other climes—why those who say so cannot pay any attention to what is going on about them, and if they entertained that thought for a moment, they would find it upset at once if they but only saw for themselves the great progress made in this country.

The main object of my lectures has been to try and show you that we are not idle at home, and to try and show you that whatever may be the requirements of this country, as far as speed, capacity, and rapidity are concerned, we have, in your own public service, men who are determined to carry out, as far as their ability will allow them (and who, I really believe, are competent to do so), all the necessities and requirements of the age.

At the conclusion of the lecture (the last of the course), the chairman (Mr. F. J. Bramwell) made the following remarks:—Ladies and gentlemen, before you leave this room, I beg that you will return your hearty vote of thanks to Mr. Preece for his course of Cantor Lectures. I am sure you will agree with me that the lectures have been most interesting and enjoyable; and though Mr. Preece says he has not been very happy while rendering them, I should have liked him to have been unhappy a little longer, and given us a few more evenings of enjoyment, which is enjoyment of the best kind, because it calls upon us to exercise all our intelligence in following out the wonderful improvements Mr. Preece has so lucidly brought before us. There are three kinds of lecturers. The first is the man who thinks he understands what he is talking about, but does not; the second, the man who does understand his subject, but cannot explain it; the third, and rarest of all, is the man who understands everything he is talking about thoroughly and completely, and can yet, at the same time, bring himself to consider that there are others who have not yet got his knowledge, and who can so describe his subject to them as to make them almost equally thoroughly understand it. Mr. Preece is one of the third class of lecturers, who, knowing the matter that he has to deal with thoroughly, can, nevertheless, bring himself down to the level of those approaching it for the first time, and send his audience away in the happy consciousness of having been instructed in such a manner as to make them capable of taking their knowledge home, and retain it. There are different ways of explaining things. Some can explain in such a manner as to enable their listeners to at once grasp and take hold of the idea, while others, after what they consider a thorough explanation of the subject, leave their listeners in such a frame of mind that they could scarcely repeat any portion of it. Any one who has listened to Mr. Preece to-night cannot fail to clearly understand the matter. I have not heard the other lectures Mr. Preece has delivered before you. The loss is mine, but I am perfectly certain that throughout the course he has thoroughly brought the subject before the audience; and, without detaining you further, I will ask you to return your hearty vote of thanks to Mr. Preece for the lectures.

Mr. PREECE: Mr. Chairman,—There are always two things necessary in every lecture. The first is the lecturer; the next is the audience; and the success of a lecturer always depends upon his audience; and, sir, I can only say that, if you had been here as often as I have, you would agree with me when I say that I could not have had a more appreciative audience.

CASSELL'S TECHNICAL EDUCATOR.—We have received Part IV. of this series, containing, amongst twenty-two articles of practical interest, one on the electric telegraph. Although we have a high opinion of the general utility of the work, we cannot say that the latter article reaches the standard of elementary knowledge and practical efficiency at the present day. For instance, the writer, speaking of a "galvanometer," says that "a deflection of 40° must not be taken as an indication that the current is just twice as strong as one producing a deflection of half that amount, or 20°." He, in fact, calls a *detector* "a form of *galvanometer*," instead of a form of *galvanoscope*. We are informed also that "at all principal stations the resistances are accurately ascertained by means of a resistance coil and a *differential galvanometer*." This statement, which was true many years ago, is no longer so. A fresh series of articles on the telegraph is desirable; and, in a succeeding edition, they will, no doubt, be forthcoming.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.

An extraordinary general meeting of the shareholders of this Company was held on the 22nd inst., at the City Terminus Hotel, "for the purpose of varying the existing powers for the issue of debentures of the Company, and authorising the issue of £450,000 consolidated debentures for the redemption of the debentures now current, and for the general purposes of the Company." Sir E. W. WATKIN, M.P., the chairman, presided.

The report of the directors expressed regret at the death of their late chairman and colleague, Mr. Henry Rawson. As to the accounts and balance sheet for the financial year ending 30th September, 1879, they had pleasure in stating that while the maintenance charges remained high, owing to the fact that the complete repairs of the cable had not yet been effected, the revenue was maintained, justifying the belief that when the remaining repairs of the line were completed the returns would be satisfactory. By far the greater part of the faulty portion of the Company's system of cables had already been renewed with sheathed cable. In a circular issued by Sir Edward Watkin, M.P., announcing that he had, at the request of the leading shareholders, and by the unanimous wish of the board, agreed to take the chair of the Company, that gentleman said, *inter alia*, "The first step required to be taken, with a view to an early payment of dividends on the £1,398,000 of ordinary stock, is to place the finances of the Company in a sound state. To this end I propose that the powers already granted by the proprietors for the issue of £450,000 debentures be consolidated by the creation of £450,000 debentures of one single class—a sum the proceeds of which are stated to me to be adequate to pay off at maturity, or at an earlier date by agreement, the existing three classes of debentures—to discharge the floating debt, and to provide for the renewal of those portions of cable which, though not worn out, are of an indifferent character—in round figures, about 400 miles. I think it is a sound principle that the ordinary stockholder should be his own mortgagee. I propose that the principal sum of the new bonds be payable in four equal instalments, the first of such instalments being due on the 1st January, 1880, the second on the 1st March, the third on the 1st August, and the fourth on the 1st December, 1880, half-yearly interest accruing from the date of payment of the calls. An option, also, to be given to pay up the unpaid calls, with 5 per cent. interest on prepayment until the calls mature, if and so far as the Company's requirements permit. I propose that the rate of interest on these bonds be 7 per cent. per annum for a period of five years, and that after that period the bonds should be redeemable at 10 per cent. premium in cash, or, failing redemption, should continue, bearing the reduced rate of interest of 6 per cent. With a cable sound in all its parts, and with the undertaking freed from debt, the shareholder who has invested his money ought to be able to look forward more hopefully than hitherto. It will be observed that this operation will in no manner increase the present capital obligations of the Company."

The CHAIRMAN, in opening the proceedings, said he had undertaken to take the chairmanship of the Company on the condition that the shareholders, as far as possible, should be their own mortgagees, and aid the directors in repairing and restoring those portions of the cable which were, to some extent, defective; and to assist in discharging the liabilities of the Company, so that at the earliest possible period the net revenue might be devoted to paying interest on the bonds and dividends on the shares. At the present time, as they were aware, the net revenue was absorbed by the cost of the renewal of the cable. There had been considerable debits to the past revenue accounts under the item of renewals. It was obvious that so long as that state of things existed, the owners of the £1,400,000 ordinary share capital could not expect to receive anything. An outline of the project had been made known to the shareholders by the circular which he had issued, and he hoped that they would assist. He himself was prepared to take his share, and he hoped that all the other shareholders would do the same, so that the whole burden should not be thrown on the shoulders of the directors. He then announced that Mr. Samuel Mendel had been good enough to join the board, and also Mr. Henry Cooke, of Manchester, and said that, with such men as Mr. Weaver, Mr. Andrews, and Mr. Cooke on the board, they would see that none of the directors had in any way been desirous of turning their backs on the Company. He proposed on that occasion merely to take a general resolution, and to leave details for the annual meeting on the 8th of January. He then moved a resolution authorising the directors to issue consolidated debentures to an amount not exceeding £450,000 for the purpose of providing for the redemption of all or any portion of the A B or C debentures of the Company, and for the general purposes of the Company, the issue to be at such time and on such terms and conditions as the directors might think fit.

Mr. MENDEL having seconded the motion,

The CHAIRMAN said he might mention, before it was put, that they had given instructions that day to obtain tenders for 400 miles of new cable—an amount which their professional adviser informed them would be sufficient, not only to restore that cable, which ought to be immediately restored, but to replace with sheath-cable portions of the cable not at present sheathed, and which, therefore, were not so eligible.

A SHAREHOLDER thought that the terms of the resolution quite upset the terms of the circular. By the resolution the directors might issue the debentures on any terms they pleased.

The CHAIRMAN said the shareholders might rely on it that the board intended to do nothing outrageous; but they must have a general authority. They might be able to issue, under certain circumstances, some portion of the debentures at rather a less rate of interest.

The resolution was carried unanimously.

Mr. BEATTIE thought they ought not to separate without thanking the chairman for the generous spirit in which he had undertaken an undoubtedly onerous duty. Had that been an ordinary meeting, he would have liked to say a few words in reference to the loss they had sustained by the death of Mr. Rawson.

The CHAIRMAN said he quite appreciated the remark of Mr. Beattie, and but for the meeting being only on a matter of routine he should have alluded to it. At the annual meeting the opportunity would doubtless arise, when the proprietors would take advantage of it.

The proceedings then terminated.

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NEW PATENTS, 1879.

4703. IMPROVEMENTS IN AND CONNECTED WITH ELECTRIC BELLS, SPECIALLY DESIGNED FOR SIGNALLING FROM THE ROOMS OF PASSENGER SHIPS AND HOTELS, AND FOR OTHER LIKE PURPOSES, *J. White.—Nov.* 19.

4718. APPARATUS FOR HOLDING THE ELECTRODES FOR USE IN ELECTRIC LIGHTING, *W. B. Godfrey.—Nov.* 20.

4785. AN IMPROVED ELECTRIC MOTOR, *T. J. Smith* (COMMUNICATED BY *H. Chameroy*).—*Nov.* 24.

4796. ELECTRIC LIGHTING APPARATUS, *T. E. Gatehouse.—Nov.* 25.

4903. IMPROVEMENTS IN APPARATUS AND IN THE ARRANGEMENT OF MECHANISM AND PARTS TO FACILITATE CONVERSATION BY TELEPHONE BETWEEN PERSONS AT DISTANT PLACES, *C. E. Scribner* (PARTLY COMMUNICATED BY *G. D. Clark, M. G. Kellog, G. B. Scott*).—*Nov.* 29.

4916. NEW OR IMPROVED COMPOSITIONS FOR INSULATING TELEGRAPH WIRES, CABLES, OR OTHER CONDUCTORS OF ELECTRICITY, *J. C. Mewburn* (COMMUNICATED BY *J. Heins*).—*Dec.* 1.

ABSTRACT OF PATENTS.

1015. GALVANIC BATTERIES, *T. J. Howell.—Dated 14th March*, 1879. 6*d*.

This consists, first, in the employment, in combination with a porous cell, of a slotted cell, tube, plate, or diaphragm; secondly, in the employment of sulphate of manganese (known commercially as white manganese) in combination with peroxide of manganese and broken carbon or graphite.

1044. ELECTRIC APPARATUS FOR TRAIN SIGNALLING ON RAILWAYS, *E. Pyer.—Dated 17th March*, 1879. 10*d*.

This relates to improvements on patents No. 3015, dated 29th November, 1861, No. 1845, dated 21st May, 1873, and No. 1013, dated 23rd March, 1874, and consists in forming the cylindrical armatures which are acted upon by electro-magnets, so as to move the signal indices or pointers of a thin shell of soft iron cut in halves, and fixed on the circumference of a non-magnetic disc, so as to complete the cylinder all but the narrow cuts separating the two half-shells. At these cuts middle portions of the half shells are notched out, so that at the intervals separating them they each present two narrow tongue pieces nearly meeting one another. The armature being polarised by two magnetic poles, the absence of metal between these tongue pieces has the effect of making the armature turn partly round on its axis with considerable force when the other magnet of the instrument is excited by passage of a current through its coils. The commutator consists of a disc of non-conducting material which can be turned into various positions. On its face are fixed certain metallic plates, and facing, but not touching them, are a number of contact springs. The disc can also be pushed inwards, so that when it has been turned in a position to ensure the desired contacts, it is pushed inwards, thus forming the required connections between some of the conductors, and breaking the connections of others.

1307. IRON TELEGRAPH POSTS, *F. Wirth.—Dated 2nd April*, 1879.—*(Not proceeded with).—(A communication).* 2*d*.

The post is made up of a central bar of rolled iron and three rods of round rolled iron, which enter a head plate on the top end of the central bar, and the lower ends are screw-threaded and enter a suitable shoe.

1374. ELECTRIC DIRECTION AND PRESSURE WIND VANES, *D. S. Vernon.—Dated 7th April*, 1879.—*(Not proceeded with).* 2*d*.

This consists of three parts, viz., the vane, an indicator, and a battery.

1383. ELECTRIC TELEGRAPH APPARATUS FOR TRANSMITTING ORDERS ON SHIPBOARD, &c., *J. Pitkin.—Dated 7th April*, 1879.—*(Not proceeded with.)* 2*d*.

The communicator or transmitter consists of a dial bearing the usual words of command, a disc of insulating material beneath carrying a circle of metallic contact springs insulated and placed diametrically opposite one another in the path of the contact pieces on the disc, and connected respectively to the two portions of the battery circuit in which the instrument is placed. The disc is rotated by a handle working over the dial, and at each passage of an opposite pair of contact pieces, or of the alternate spaces over the contact springs, the circuit is completed or broken, the completion of the circuit corresponding with the passage of the handle from one division of the dial to another.

1387. DYNAMO AND MAGNETO-ELECTRIC MACHINES FOR LIGHTING, PLATING, &c., *A. W. Lake.—Dated 8th April*, 1879.—*(A communication.)—(Not proceeded with.)* 4*d*.

This consists, first, of improved forms of the armature space enclosed by and between the pole faces of the electro-magnets of magneto and dynamo-electric machines. Secondly, improved form of armature cores. Thirdly, a rotary automatic circuit maker and breaker. Fourthly, combining a rotary circuit maker and breaking with an outer or external circuit or shunt, so arranged as to divert or draw out of the main circuit the opposing currents, and by this means neutralising their evil effects.

1622. PRODUCING ELECTRIC LIGHT, *R. C. Thomson.—Dated 24th April*, 1879.—*(Not proceeded with.)* 2*d*.

This consists in the employment either in a dry powdered, or in a moistened and plastic state, of the carbon or carbonaceous material usually made into solid pencils or sticks.

1635. ELECTRIC LIGHT APPARATUS, *J. MacKenzie.—Dated 25th April*, 1879. 6*d*.

This relates to apparatus for governing the distance between the points of the electrodes or carbons of electric lamps where they are arranged vertically or opposite to each other.

TRAFFIC RECEIPTS FOR NOVEMBER, 1879.

COMPANIES.	Nov. 1879.	Nov. 1878.	Incrse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company.....	—	—	—	—
Cuba Submarine Company.....	3,000 estd.	2,609	491	—
Direct Spanish Telegraph Company	1,334	1,002	332	—
Direct United States Telegraph Company ...	—	—	—	—
Eastern Telegraph Company	46,147	37,170	8,977	—
Eastern Extension Telegraph Company	26,379	25,280	1,099	—
Great Northern Telegraph Company	16,653	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company..	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—
West Coast of America Telegraph Company.	—	—	—	—

ADDRESSES.

*** NOTICE.—It has been decided to devote a portion of the advertising space of *The Electrician* to giving the addresses and specialities of the principal firms of Electricians, Engineers, &c. A moderate charge per annum will be made for the insertion of such addresses weekly, and firms desirous to be included in the list are requested to apply to the Manager, 396, Strand. The addresses must not occupy more than five lines.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

PETER BROTHERHOOD, Engineer, 56 and 53, COMPTON-STREET, GOSWELL-ROAD, E.C.
Specialities—Patent 3-Cylinder Engines (Silver Medal, Paris), as used by Siemens, Gramme, and Wilde for driving Electric Machines.

RANSOMES, SIMS, and HEAD, Orwell Works, IPSWICH.
Specialities—Portable and Stationary Engines, fitted with patent governors, as tried in the electric lighting experiments on the Thames Embankment.

ABBOTT and Co., NEWARK-ON-TRENT.
Specialities—The "Standard Size" Vertical Cross Tube Boilers. Illustrated catalogue, giving every detail of a variety of Boilers, 2s. 6d., post free.

CARBON ELECTRODES COMPANY. Works: 39, COMMERCIAL-ROAD, EAST.
Specialities—Carbon Rods of all sizes for Electric Lighting. Also, Plates and all other Moulded Carbon Goods. List of prices on application.

M. THEILER & SONS, Telegraph Instrument Manufacturers, 86, CANONBURY-ROAD, N. Works: ALWYNE-LANE, N.
Specialities—Morses, Polarised Relays, Saunders' Curb Keys, Type Printers, Recording Sounders, Duplex Apparatus (Theiler's Patent).

THE BRITISH ELECTRIC LIGHT COMPANY (Limited), 41, PARLIAMENT-STREET, WESTMINSTER, and 17, WATER-STREET, LIVERPOOL.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

L. CLARK, MUIRHEAD, and Co., Electric Telegraph Engineers and Manufacturers, 29, REGENCY-STREET, WESTMINSTER.

INDIA RUBBER, GUTTA PERCHA, and TELEGRAPH WORKS, COMPANY (Limited). Offices and Warehouses: 106 and 100, CANNON-STREET, LONDON.

AUGUSTUS WESTWOOD and Co., Mechanical, Telegraphic, and Gas Engineers, COMMERCIAL CHAMBERS, WEST BROMWICH.

The SCHOOL of SUBMARINE and MILITARY TELEGRAPHY, 4, GEORGE-STREET, HANOVER-SQUARE, LONDON, W.

DAVIS and TIMMINS, Screw Manufacturers, BOWLING GREEN-LANE, FARRINGDON-ROAD, E.C.

ELECTRICAL AND SCIENTIFIC APPARATUS.—WHOLESALE MANUFACTURERS OF ELECTRIC BELLS.—Our new metallic base Electric Bell and Constant Battery Indicators and Telephone Switches. Induction Coils of highest finish; Terminals, Carbons, and all materials. Silver and Nickel Plating and Gilding. Instruments made, repaired, or altered on the premises. Illustrated Electric Bell list free. Complete catalogue two stamps. Special quotations to the trade.—DALE and CRAMPTON, Electricians and Opticians, 4, Little Britain, London, E.C.

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SLIP

CAPE CABLE.—This cable has been successfully laid, and is now open for traffic.

CABUL.—General Roberts reports that the telegraph line which was partially destroyed by the enemy is being rapidly repaired.

TRANSVAAL TELEGRAPHS.—The only tender received by the Volksraad for the construction of the telegraph lines in the Transvaal authorised by the Volksraad last session is that sent in by the Cape Government.

TELEPHONE CALL.—It is said that a Utica artisan has patented an attachment signal for the telephone. It has something of the nature of the signalling apparatus in use on some railways, or of electric bells, inasmuch as every time a call is made a red disc makes its appearance.

ELECTRICITY IN THE FUTURE.—Dr. Werner Siemens, of Berlin, in a lecture on "Electricity in Service of Life," dwelling on the electric transmission of force, prophesied that "the energy of the solar rays, manifested in currents of air or in falls of water, may by-and-bye, through the electric current, furnish all necessary heat, and render us independent of ordinary fuel."

THE ELECTRIC LIGHT AT SEA.—The passengers by the Inman steamer City of Berlin, during her recent trip to New York, with the electric light on board, have addressed a note of congratulation to the company. The experiment of lighting the vessel by electricity has proved highly satisfactory. Not only was the saloon brilliantly illuminated, but the steerage, usually the gloomiest part of the ship, was lighted up in all parts.

STEELING COPPER PLATES.—R. Böttger uses 100 parts of ammonio-ferrous sulphate, and 50 parts of ammonium chloride dissolved in 500 parts of pure water, a few drops of sulphuric acid are added, the liquid is maintained at 60° to 80°, and the copper plate is immersed in this liquid, and made the cathode of a system of two or three Bunsen cells, the anode consisting of an iron plate equal in size to the copper. In a few minutes the copper plate becomes covered with a hard steel-like deposit of iron.

THE NEW FRENCH ATLANTIC CABLE.—The stations of this company are, we believe, being rapidly proceeded with, and the company may possibly open the line in Paris as soon as they are finished. There is, however, some inclination to defer the inauguration of the cable until the section between Penzance and Brest is submerged by the ss. Poyer-Quertier. Notice is given in the *Canada Gazette* that application will be made for an Act to incorporate the French Atlantic Company, and to create its shareholders a corporation within the Dominion of Canada, under the name of the "French Atlantic Cable Company."

AN electrical signalling instrument of a very simple sort has been devised by Mr. William Hadden, of 145, Broadway, New York, and is illustrated in the *Scientific American* for Dec. 20. It consists of a plain grooved strip of wood or other non-conductor, fitted with metal contact pieces in the grooves, arranged in pairs according to the determined signal. These points are connected to the line, and the battery is connected to a contact maker of spring metal, and split so as to bear on the two contact pieces of each pair. A signal is made by merely drawing the spring along the groove over the tops of the contact pieces. This apparatus is applicable to fire alarm and district telegraphs, &c.

MODIFICATION OF LIPMANN'S ELECTROMETER.—In order to avoid the use of a microscope with Lipmann's electrometer, M. E. Debrun has devised the plan of making the instrument so that the surface of the mercury whose displacement is observed is contained in a cylindrical tube of one-fourth of a millimetre in diameter, 0·15 metres long, and divided into millimetres. This tube makes an angle of 10° with the horizon. According to M. Debrun, the change of level is about 75 millimetres for one volt of electromotive force, and with the aid of a vernier this gives a sensibility to at least $\frac{1}{750}$ of a volt. The tube is experimentally divided into parts of equal electromotive force.

TASMANIA.—The latest Government report, giving details for 1878, states that the number of inland telegrams for that year was 53,683, giving a revenue of £3,237 12s. 11d. Of external telegrams there were 15,514, giving a return of £1,038 19s. 3d. The total revenue from this source was £4,276 12s. 2d. Of unpaid messages there were for the public service 15,116, and on account of shipping 6,000. The expenditure over the same period was for salaries and maintenance, £5,070 0s. 7d.; on account of cable (opened 1st May, 1869) subsidy, £4,200, being a total of £10,170 0s. 7d. At the end of the year there existed 59 stations, 692 miles of line, 910 miles of wires, with a permanent staff, paid by the Government, of 76 persons.

STORED LIGHT.—The luminous paint of M. Balmain has been brought recently into prominence by Messrs. Ihloe and Horne, of 31, Aldermanbury. The paint is rendered self-luminous by mixing with it a sulphide of lime or other "phosphorescent" material, and on exposing the painted surface to daylight, the light of burning magnesium, or of an electric arc, the light waves seem to set the molecules of the salt into a vibration which lasts for several hours. The result is that on taking the painted surface into a dark place a pale violet light is emitted from it. The projected applications of the paint are for buoys at sea, lamps for powder magazines, wine cellars, compartments of ironclads, and advertising purposes, but the uses to which it may be put are almost infinite.

SCOTTISH TELEPHONIC EXCHANGE.—The prospectus of this company contains the information that telephone exchanges are in general use in eighty-five of the principal towns of the United States. In Chicago, as has been previously stated in *The Electrician*, there are over three thousand members in communication. The first telephonic exchange in this country was started in July, 1879, at Manchester. It is also stated that the time required to put two members in communication does not exceed half a minute. It may be useful here to make a statement, and ask our readers if they can supply any corroboration to the story. A gentleman assures us that the string telephone was in use in Ceylon quite twenty-five years ago, and that it was to be seen in business houses.

ELECTRICITY AND CANDLE-FLAME.—M. Borlinetto, professor of physics at Paria, reports the following curious observation which he has made, in an article on the effects of the electric spark in insulating liquids, published in our contemporary, *l'Electricite*, for Dec. 5. If the flame of a candle is approached to the negative pole of a Holtz machine, the luminous part which forms the flame is strongly attracted; on the contrary, approached to the positive pole it is repulsed; but the blue base of the flame, constituted of oxides of carbon or carbon vapour, is attracted by the positive pole, although it was not so evident that the vapour was repulsed by the positive pole. In the atmosphere

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surrounding the poles the combustion of the candle was greatly increased and the flame rendered more brilliant.

THE AURORA.—An interesting book by Mr. J. Rand Capron, F.R.A.S., has just been issued from Mr. Spon's press. It is called "Aurorae: their Characters and Spectra," and is an original discussion as well as a faithful description of the phenomenon of Arctic lights. Among other conclusions the author finds that the balance of evidence is against *sound* being emitted by aurorae, and that the displays range from heights close to the earth's atmosphere up to 1,000 miles. The coincidences of aurorae with mocksuns would seem to indicate that clouds of ice particles are sometimes illuminated by the electric discharge. Mr. Capron dismisses the idea that there is a connection between aurorae and zodiacal light, the latter being apparently some form of reflected sunlight. The relation of the aurora to the solar corona seems equally shadowy, but it is noted that the colours of Jupiter's bands appear to be brightest during periods of auroral frequency.

WIRE GAUGES.—A sheet containing several useful tables and data for the guidance of those who use wires for electrical and other purposes has been issued by Mr. W. F. Dennis, of 101, Leadenhall-street. The most important of the tables is that in which the new millimetre gauge is compared with the Birmingham and Paris gauges, with the Westphalian pin wire gauge, and the common Westphalian gauge. The sizes of the wires are given in decimals of the inch as well as in millimetres, and the approximate weights per 1,000 metres are given in kilogrammes, these weights being applicable to iron wire, a fact which, by the way, might be stated in the heading to the column of weights. Another table gives the size, weight, length, and strength of the iron wires mainly used by the Postal Telegraph Department, the telegraph companies, &c. Amongst the remaining tables, that of the Warrington iron manufacturers, and the copper wire gauge, expressed in decimals of the inch, will be of interest to telegraph engineers and electricians.

QUICK WORK BY DIRECT CABLE.—A striking instance of the use of the ocean telegraph in business occurred last week, when a Wall-street broker having secured the use of the Direct Cable immediately after the opening of the Board, purchased a quantity of stock, and telegraphed to his broker in London an order to sell it. His broker's office being opposite the London Stock Exchange, and the London office of the Direct Cable Company being next door to it, no time was lost in completing and reporting the sale, and in *sixteen minutes* from the time of sending the order advices were received in New York that the stock had been sold. The following are a few other instances of the daily speed with which cablegrams are despatched by the "Direct Cable":—Message No. 50: Answer from London in 19 minutes. Message No. 57: Answer from London in 16 minutes. Message No. 67: Answer from London in 15 minutes. Message No. 70: Answer from London in 21 minutes. Message No. 71: Answer from London in 13 minutes.

MR. CROMWELL F. VARLEY'S TELEPHONIC SPECIFICATION.—M. Alfred Niaudet, in his work on "Telephones and Phonographs," speaks in very high terms of Mr. Varley's telephonic researches. "These," he says, "are embodied in an English patent specification, dating from 1870. This document is one of the most interesting of those we have studied in relation to the present work. It is a short memoir very much condensed, and yet very clear; it may be said that there is a new idea in every paragraph. The memoir in question must undoubtedly have exercised a great effect upon subsequent researches; the well-known name of the author, and his reputation in Europe and in America, justify this assertion; we may also give a curious proof of it, viz.: that his specification, published by the Patent Office, ran through a first edition, and that a second edition has been printed, a copy of which we have now before us." M. Niaudet gives some dozen pages to the description of the telephonic inventions of Mr. Varley.

RADIATION FROM INCANDESCENT PLATINUM.—The author, M. J. Violle, says the *Jour. Chem. Soc.*, made a certain number of determinations of the intensity of the red light emitted by platinum at temperatures between 900° and 9775°, its fusing point. He gives an empirical formula representing these results, the intensity I of the light, at the temperature t, being found from $\log. I = -8{\cdot}244929 + 0{\cdot}011475\ t - 0{\cdot}000002969\ t^2$. From this he deduces certain theoretical consequences, such as that the intensity of the *red* light would attain a maximum at a temperature of 1933°, &c. He suggests that the temperature of a furnace might be ascertained by the easily made photometrical determination of the intensity of light given off by a piece of platinum placed in it. On transmitting the radiation from fused platinum through rock-salt and alum respectively, he found that the luminous heat passing through the alum was 2-9ths of the total heat passing through the rock-salt, and, as Dessains has found in the spectrum of incandescent platinum only an insignificant fraction of luminous heat (*ibid*, 84, p. 285), the author concludes that at 1775° the more refrangible radiations have a higher relative value in the spectrum of platinum than at a point a few hundred degrees lower.

EDISON'S CARDBOARD LAMP.—*The Times* Philadelphia correspondent has interviewed Mr. Edison, and inspected his latest lamp, together with the generator of the current, the regulator and the meter, and pronounces very favourably upon them. Of course the opinion of a newspaper correspondent is to be taken for what it is worth; but we suppose there can be no doubt about the facts of which he was an eye-witness. Two lights had been burning for ten days, and he saw sixty in all burning for seven hours on end while he was at Menlo Park. Cardboard seems to him able to resist rough usage, turning the current off and on for thousands of times, and raising the intensity of the light to 400 candles. Each lamp emits very little heat, and there is no danger of fire. The globe is exhausted to one-millionth of an atmosphere by means of a Sprengel pump with a McLeod gauge. The resistance of each lamp is 100 ohms, and it is made to yield a light of 16 candles, but this can be raised or lowered with the ease of gas. The central regulator maintains an even current, while the meters accurately measure the supply furnished to each consumer. Mr. Edison finds that the best generators are of 5 to 7 h.-p. each, each horse-power maintaining eight lamps. Each lamp costs about 25 cents to manufacture, while a supply of electricity equivalent to 10,000 cubic feet of gas can be produced for 10d. or less. The cost of the light is given by Mr. Edison in these terms:—The consumption of 3lb. of coal in the steam prime mover will maintain eight to ten lamps for one hour; that is to say, 3lb. of coal will furnish, say 150 candle-lights, or ten gas jets for an hour. The light is beautifully bright, clear, and mellow, while being steadier and more agreeable to the eye than gaslight. Mr. Edison's establishment at Menlo Park is now lit up by it, and he is shortly to erect 800 lamps in the village itself. The system is also to be introduced at once into New York.

THE "BRUSH" SYSTEM OF ELECTRIC LIGHTING.—On Tuesday, the 23rd ult., an exhibition of this system took place at the premises of the Anglo-American Electric Light

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Company, Hatton-garden. The system in question, which is new in this country, although already in operation in America, consists in the use of the "Brush" dynamo machine in conjunction with any required number of "Brush" lamps or carbon-regulators, arranged in series or in single-circuit; the carbons used being manufactured by a process which is stated to ensure special purity, leaving only ½ per cent. of foreign matter in the material. The accidental break-down of one or more of the lamps does not in any way affect the remainder, any lamp offering an undue resistance being instantly thrown out of circuit by means of an automatic "cut-off." Sixteen and eighteen lights were exhibited in a single circuit; each light being stated by Mr. Ladd as equal to 960 standard candles, when the photometric measurement was made on a level with the arc. Consequently this value would not express the maximum illuminating effect, which is obtained at an angle of 45 degrees below the level of the lamp. The horse-power expended to obtain the sixteen lights was stated to be about 13·5; and the quantity of carbon consumed was 1½ in. per hour per lamp. The length of each arc was about 2 millimetres. An important advantage of the system is that the horse-power in action may, by a simple manipulation, be adjusted according to the number of lamps, or rather the total resistance, in circuit; so that the number of lights may be diminished or increased as required, within the limit of the maximum number, without any waste of energy. It is claimed that the system is specially adapted for maintaining lamps at long distances. The ordinary "Brush" lamp burns for eight hours, and the double-rod lamp for sixteen hours, without renewal of carbon. We can bear testimony to the fact that the lights were remarkably steady and colourless; and we observed no splitting of the carbons, such as frequently occurs with a defective material.

Indian Telegraph Laws.—The powers and privileges of Government in calling for messages sent over the telegraph wires in India are (says the *Madras Mail*) probably not generally known. Section 5 of the Telegraph Act (Act No. 1 of 1876) runs as follows:—"On the occurrence of any public emergency, or in the interest of the public safety, the Governor-General in Council, or the Local Government, may take temporary possession of any line of telegraph established or maintained by any company or person licensed under this Act, or may order that any message to or from any person, or relating to any specified subject, shall be intercepted or communicated to the Government or any officer thereof mentioned in such order. If any doubt arises as to the existence of a public emergency, or whether any act done under this section was in the interests of the public safety, a certificate signed by a Secretary to the Government of India or to the Local Government shall be conclusive evidence on the point." Section 17 of the Act provides that any telegraph officer who . . . "wilfully or otherwise than by the official order of a Secretary to the Government of India or the Local Government, or of such other officer as the Governor General in Council authorises to give such order, intercepts any message on any part thereof, or divulges any message, or the purport of any message or of any part thereof, to any person not entitled to receive the same . . . shall be liable to imprisonment for a term not exceeding three years, or to fine, or to both." Section 21 runs as follows: "Whoever transmits or causes to be transmitted by telegraph a message which he knows to be false or fabricated shall be liable to imprisonment for a term which may extend to three years, or to fine, or to both." The whole of the Telegraph Act is contained in twenty-three sections. We imagine that few people are aware of the extraordinary "powers and privileges" it confers on the Government in India. That such an Act would be tolerated in any British community out of India seems highly improbable. It goes without saying that these powers and privileges were never intended to be exercised except under the most exceptional circumstances, such as danger to the State, &c.; but, as the Act stands, it is left to a local Government to determine what is a matter of "public emergency," and the Act, therefore, virtually authorises a fretful or meddlesome Government to pry into the history of almost any telegram that may be printed in a newspaper. It is just as well that both senders and receivers of telegrams should be aware of this fact, so that they may take precautions accordingly.

Electrolysis of Water (1).—Galvanic Polarisation (2).—The object of the experiments by F. Exner, recorded in the first of these papers, is to prove that the electrolytic decomposition of water takes place whenever the electromotive force of the primary current exceeds in the smallest degree the electromotive force of the simultaneously developed polarisation. In his experiments the author used electrodes of the finest platinum wire, and these were viewed through a lens, in order that the first indications of the extrication of gas might be observed. The primary current was derived from a thermopile, so arranged that the electromotive force could be gradually increased by bringing more and more elements into the circuit. The electromotive forces of the primary and polarisation currents were measured by methods described in *Ann. Phys. Chem.*, 6,338. Up to about 2·00 Daniell cells, the primary current developed a polarisation electromotive force equal to its own. When the primary current was equal to 2·30 Daniell, the polarisation current was equivalent to 2·03 Daniell, and at this value it remained constant, notwithstanding the further increase of the primary current. The decomposition was first observed at this point, namely, when the primary current had an electromotive force exceeding that of the polarisation current by 0·27 Daniell. These were the results with pure water free from dissolved gases; the effects of adding a few drops of sulphuric acid were that the decomposition commenced with a somewhat weaker primary current, and the excess of its electromotive force over that of polarisation was now only 0·09 Daniell. With electrodes of copper immersed in dilute sulphuric acid, decomposition first took place with a primary equal to only 0·54 Daniell, and exceeding the polarisation current by only 0·03 Daniell. Similar experiments with other metals led to the conclusion that an effective electromotive force of less than 0·03 Daniell suffices to decompose water. A general law of electrolysis is derived from the discussion of these experiments, namely, that in any closed circuit, of which an electrolyte forms a part, the electrolyte is decomposed as soon as an effective electromotive force, however small, predominates throughout the general circuit. The researches described in the second paper have for their object to prove that there is no essential difference between a polarisation element and an ordinary one. The source of the current is, in the latter, the oxidation of zinc; in the former, it is the oxidation of hydrogen. The paper gives in detail the numerical results of experiments with difierent substances, the experiments forming 29 series. The correctness of the author's conclusion is exemplified by a table showing the close correspondence of the calculated and the observed electromotive forces of polarisation currents in 24 cases where different electrolytes and electrodes were employed. The discussion of the results includes some observations on the theories of electrolysis and related subjects. —*Journal of the Chemical Society.*

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TECHNICAL EDUCATION.

SIR: At a recent meeting of the Society of Arts I gave a sketch of the scheme which seems to me most suitable for benefiting the trades of England; and in a letter to *The Times* on the 17th inst. I stated that the system of technological examinations which is now being vigorously carried out by the City and Guilds of London Institute is growing rapidly into such a scheme as that which I advocated.

I objected to Professor Huxley's sweeping condemnation of the supineness of the City Guilds, because I knew that a great work has really been begun by them, and that they mean to carry it out thoroughly. The enclosed paper, which was written some time before the meeting of the Society of Arts above referred to, contains what has always seemed to me the only trade-school scheme which is possible in England.

In asking you to publish it, and thus to begin a discussion of very great importance at the present time, I want to correct the mistake which a hasty reading of my letter in *The Times* seems to have produced, namely, that any man of experience in technical education disapproves of the measures recommended in 1878 by Professor Huxley and his colleagues.

Scientific Club, 22nd Dec., 1879. JOHN PERRY.

The old system of apprenticeship in England obliged the master to teach a trade in return for a certain term of service. In consequence of the nature of trade having changed, it is now impossible for the master to carry out, personally, his part of the contract, and anyone who has been in an English workshop must know that, what with the ignorance of masters as to what goes on in their works, what with the duty of a foreman having become that of a taskmaster, what with the old idea having died out of a master's duties to his servants possessing no money equivalent, an apprentice gathers a poor knowledge of his trade with the greatest difficulty, even when he is not hampered by a want of elementary education in Physical Science. The workmen with whom he comes in contact regard their engagements from a mere pecuniary point of view; they will leave a workshop to-day and enter another to-morrow. In fact, even if they had powers of teaching the apprentices, they have no interest in so-doing; or rather, they have an interest in keeping back as a trade-secret any information which can give them, as its possessors, a temporary importance.

It is high time that a change should be brought about in the apprenticeship system of England. The ignorance of workmen is a canker at the root of all the trade supremacy of the country, and it is our duty to see that it is cleared away.

The objection to the establishment of State-paid trade schools seems to be insuperable, in this, that it is wrong to benefit particular trades at the expense of the whole people of the country, and, however much we may extend the operation of any trade-school system, it can never be equally beneficial to all people. By compelling masters, whose fortunes have been created by and are dependent on particular trades, to take cognizance of the facts—that they have duties to perform in regard to their apprentices; that they have hitherto been in the habit of entering into contracts without having any means of performing their parts of them, and that it is better in every way to see a higher duty towards not only their apprentices but their workmen than is to be cleared off by a weekly payment of money—by doing this we shall not only improve trades, but we shall bring back again those old feelings of loyalty of men in different positions to one another, whose absence is the social difficulty of modern England.

It is generally recognised to be the duty of the State to insist that all children shall get a fairly good elementary education. In a short time, when the great primary expenses, such as that of building, have been cleared off, there can be no doubt that the education insisted upon all over England will include a little Mathematics, Physics and Chemistry. That it is possible for all children such as now attend the primary schools of England to benefit by teaching of this kind, is well known to everybody who has studied the work of the Irish National Education Commissioners, and must be evident to anybody who cares to visit a large national school in Ireland, such as the Model School at Belfast. To provide the children of the country with education in Natural Science is recognised as a duty of the State by the payment of money every year to teachers of science and art classes; and in these two ways, that is, by giving very elementary instruction in primary day schools, and more advanced instruction in evening classes, do I think that the State will be performing a duty which comes in a legitimate way within its sphere. For a long time to come, it will be difficult to obtain such instruction as every one who has examined the working of Science and Art evening classes knows very well; but the improvement which takes place year by year in such teaching, shows that the time must come when everybody in England will obtain a sound elementary knowledge of Natural Science at a cheap rate. To provide this general instruction is the duty of the State:—(1) because it is equally beneficial to us all that the children shall be educated in elementary Natural Science, (2) because experience shows that a general scheme is necessary for effecting the purpose, and (3) any such general scheme is so large that it can only be taken up by the State. But here I think that the functions of the State must end. Education in science applied to particular trades must be the care of the people who most immediately benefit by those trades.

Having come to the conclusion that apprentices must be taught their trades in a more efficient manner than the one generally adopted in England, and also that the apprentices who are to be taught in the future will possess a sound elementary knowledge of Natural Science obtained through the agency of primary schools and evening classes, how is this instruction in their trade to be given them? If we consider the great number of apprentices who are to receive instruction, we must, in spite of the well-known experiments on the continent, come to the conclusion that the practical part can only be given to them in ordinary workshops.

The experience of all people connected with industrial schools and workshops attached to prisons is that the work turned out, even when it can compete with outside work, is done at a great pecuniary loss. Workshops established generally throughout the country for the education of apprentices would labour under the same and other difficulties. 1st. They would require a fair proportion of workmen to the number of apprentices and would consequently form important and possibly unnecessary additions to the manufacturing power of the district in which they were established. 2nd. It would be difficult to prevent the workmen being intimidated by trades unions and the jealousy of manufacturers. 3rd. Although established as schools it would be necessary to make for them a connection of customers, and as there is so much competition in trade a large staff of travellers, agents, and clerks would have to be kept up. The cost of advertisements, the necessity of changing machinery as soon as it became antiquated in form, the necessity for having a good business man as manager, who would keep himself well acquainted with the state of trade, these expenses would be the same in the school as in a manufactory. 4th. The special requirements of a school would be additional expenses of such magnitude that there must always be great pecuniary loss in competing with other manufactories.

It has yet to be proved that any success attends the establishment of such trade schools as we are now speaking of in France and Germany; and even if these were successful, since they have rather been established for the creation of trades in districts where such workshops had hitherto no existence, than for the very different objects of which we are now speaking and under such different circumstances, I contend that they can never prove a success in England.

A trade can only be properly learnt in a real workshop where there are many men as well as apprentices. This statement has not been disproved by any of the Continental experiments which have hitherto been made, and it is a statement which will be made by all men practically acquainted with workshops, in spite of the fact that boys in a school workshop will construct things useful to themselves or in their own households. I established what is, I believe, almost the oldest workshop existing in any public school when I was a master at Clifton College, and found it a complete success in every way; but although we provided a competent foreman, and the boys had two or three hours a day to devote to their work, their manual dexterity at the end of three years was far inferior to that of the youngest apprentice in a real workshop at the end of one year. Objection may be taken to arguments founded on such particular experiments as this, but there is always the fact that great manual dexterity has never yet been acquired by any man whose experience has not begun and ended in a real workshop where there were more men than apprentices.

The object in view in establishing workshops in connection with science classes has always been that of giving students an intimate acquaintance with the properties of materials, and I consider that no classes in Natural Philosophy can be carried on efficiently unless the students use the saw and plane, the hammer and chisel, the forge and the lathe. But this is very different from instruction in the trades of the carpenter, fitter, blacksmith, or turner. In learning their trades, apprentices must mix much with workmen, work near them and on the same jobs, and lay themselves out to help and please the men whose manual dexterity they admire. But it is no less true that they must be taught the general principles of their trade in an efficient manner.

The general principles of a trade, or what may be called the application of the principles of Natural Science to a trade, cannot be learnt from workmen, and can only be learnt by attend-

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ing lectures and lessons specially adapted to the trade; and it is in the establishment of such technical classes in the neighbourhood of workshops that I look for improvement in English manufactures. Thus, although we do not want to change our system of letting apprentices learn much of their trade from ordinary workmen, we might cause masters to see that their apprentice not only attends the schools of the district where Natural Science is taught but also that he gets time and the opportunity of attending classes where the application of physics or chemistry to his particular trade is taught.

It is sometimes used as an objection to the scientific education of workmen that boys who attend science classes do not find any great ease in learning their trade. This I grant as a fact, and if we consider how vaguely a pupil at science classes of the common kind gets acquainted with scientific principles, how far removed these principles are from being directly applicable in a man's trade, how well he knows that existing workmen get along without a knowledge of scientific principles, and if we consider the hundred other influences which cause him to doubt the usefulness of his scientific education, we shall discover the reason why attendance at science classes has hitherto seemed to be followed by no useful results. There is a very great difference in the positions of an apprentice who has learnt a little theoretical mechanics, and physics, and chemistry, and who has nobody to show him the application of his knowledge, and another apprentice who has been taught the application of scientific principles to his trade. I have myself experienced the miserable feeling of the first, when a boy. I was a fairly good mathematician, and was fond of natural science, but in every direction I found that it was impossible to apply my knowledge in mechanical engineering. I am sorry to think how much time was wasted and misery experienced before I was able to apply my scientific knowledge to the operations going on in the workshops. I have, however, lectured to boys already acquainted with Natural Philosophy on the application of their knowledge in mechanical engineering, at one of the greatest of technical colleges, the Imperial College of Engineering in Japan, and I have observed how rapidly these boys acquired dexterity and knowledge of their trades in large workshops during their vacations from college, and this is the experience of my colleagues in the Telegraph, Mining, Building, and Chemical departments of the college. It is the experience of all professors in technical colleges that their students are capable of picking up a good knowledge of a trade in half the usual time, although placed among workmen in the same way as ordinary apprentices.

For the great body of English apprentices what I advocate is the establishment of classes in the neighbourhood of workshops, where, during two hours a day, they may learn how a knowledge of Natural Science is applied in their particular trades. These classes ought to be day-classes, because, as it is the duty of masters to educate their apprentices, and as we cannot give apprentices less leisure time than workmen have, and as their pay is always very small in comparison with that of men, the time necessary for instruction in their trade ought to come out of the regular working hours.

There is a part of the education of an apprentice which cannot easily be looked after by any organisation, and this because there are really trades in which secrets are of importance—I mean his experience in the workshop itself. If it were possible to have an instructor who would devote his time to the instruction of a certain number of apprentices in a district, who might be admitted to the workshops to spend, say, a quarter of an hour or more with each apprentice per week, a man not only acquainted with the trade but with Natural Science, I should think the scheme complete. Possibly, in particular trades, an organisation of masters might enable this idea of instructors to be carried out, for the expense would be inconsiderable per boy, and, in many important trades, there is no great objection to a stranger's coming into the workshops. Indeed, in a few cases, the only objection would be one of expense, as there might be a sufficient number of apprentices under one firm to take up the whole time of such an instructor.

Even without these instructors, however, our scheme of education would be pretty complete. At all events, such instruction as I wish to see given in the technical classes would enable apprentices to learn their trades with a thoroughness not obtainable in any way at the present time.

The initiatory step in carrying out such a scheme will involve the outlay of a large amount of money, and the City Guilds of London seem to be, just now, the only organisation of trades in a position to undertake it. They have already taken over the examinations of the Society of Arts in the application of science to particular trades, but it seems to me that they ought previously to have insured instruction. In the present case, I think that it is useless to follow the example of the Science and Art Department, for previous to 1860 the country contained numbers of men who had a notion of what the teaching of natural science consisted in, but at the present time, how few there are who have thought of the teaching of applied science. The first step to be taken by the City Guilds is, to show the country how far it is possible to teach the application of science to particular trades. By the help of engineering colleges, the Royal School of Naval Architecture, the School of Mines, the Yorkshire College of Science, &c., it has already been shown that some such teaching is possible. But the new scheme must comprehend the teaching of the application of science not only to mechanical engineering, mining, weaving, and dyeing, but to all the great trades of England. If we consider what difficulties will surround such a scheme from the beginning, in finding men capable of instructing themselves first and then adopting the best means of instructing others, the cost of experiments which fail perhaps several times to give the results expected, and the expense of buildings and apparatus, we shall get a small idea of the magnitude of the undertaking and how useless it is to think of any other organisation than that of the City Guilds taking it up.

Technical colleges, established in London, would have functions which it may be a little difficult to define at the beginning, but it is evident that they would occupy the position of universities to which all the technical classes of the country would look for guidance and examination. One kind of college which might be established in a manufacturing neighbourhood would have night classes for apprentices who could pass a certain examination in Natural Science, give them further instruction in certain parts of mathematics and natural science and perhaps modern languages, and afterwards thorough instruction on the application of science to their particular trades. Such a college might be utilised in the day time in training boys from primary and other schools in pure and applied science and the use of tools; and arrangements might be made for getting these boys entered as apprentices at workshops at later ages than other apprentices and for shorter periods of service. Apprenticeship and education finished, either class of students might become foremen of workshops or teachers in technical schools throughout the country.

Another kind of college that should be established in London, not necessarily in a manufacturing neighbourhood, would provide for other trades just that kind of instruction which the School of Mines provides for mining—that is, no connection would be maintained with manufactories, its students would devote no part of their day to workshops, although, perhaps, certain parts of the year might be set apart for either visiting many works or for working in particular places. Such a college as this might well become the heart of the whole system, with the best paid professors and buildings and apparatus, and with the general office, sending out men trained to become professors at the other colleges or to become managers of works.

We have no great difficulty in understanding how this central college would work, for we have the School of Mines before our eyes, and its system of high fees for rich students and scholarships for clever poor students is well worthy of imitation. It is the secondary colleges for manufacturing districts which will give most trouble as costly experiments. Nevertheless, I think that a secondary college, although costing, perhaps, only fifteen or twenty thousand pounds to establish, will have as important a function to perform in the education of the manufacturers of the country as the central college of five times the cost. In fact, the establishment of the central college is a comparatively simple matter. The four or five great technical colleges of the world will be useful for purposes of imitation and improvement. But where can we find an example of such institutions as are required in our secondary colleges—colleges specially adapted to the peculiar needs of England?

When I read the inaugural address at Cowper-street of my late colleague, Professor Ayrton, I hoped that a great attempt was about to be made to solve the problem. But the information I have been able to gather of the Cowper-street scheme shows that as an experiment it is too small to lead to important results. Unless the Guilds are prepared to spend, say twenty thousand pounds at Cowper-street, and to appoint additional professors with energy and experience like the two they have already chosen, the initiatory step in a scheme of technical education for England must still be regarded as yet to be made. The experiment will have to be made on a larger scale before it can promise success, and I think that the condition of the country and the riches of London warrant the commencement of a much larger undertaking without further loss of time. I would not advise the City Guilds to do more than establish a central college and these secondary colleges in suitable manufacturing neighbourhoods. They have already a scheme of examination for technical classes. The rest will be the easy task of organisations of men engaged in manufacture throughout the country.

JOHN PERRY.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

We cannot undertake to return drawings or manuscripts, and must, therefore, request Correspondents to keep copies.

All communications to be addressed to 396, *Strand, London, W.C.*

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THE CAPE CABLE.

"The final splice was made off Zanzibar on Christmas Day." This sentence completes a phase in England's history during 1879 which is at once interesting and tinged with sadness. The early part of the year brought us, after a tedious delay, news of disaster to our troops and dismay in our South African colony of Natal. The tale is too well known to need recapitulation. The proof that procrastination is dangerous was once more startlingly given. The conclusions of the country forced the Government to reconsider the question of telegraphic connection with South Africa. The failure of the old Red Sea line, and the consequent payment of subsidy for which no return was given, had previously made the Government very cautious as to promises of support for any cable scheme. The foremost workers in the field of submarine telegraphy had long desired to add this link to the system of the world's telegraphs, but their efforts had been frustrated by the supineness of the "powers that be." The hour of need came, but the link was wanting. Henceforth, however, unless accident befal, none of our large colonies will be beyond speaking distance with the mother country. New Zealand, Australia, India, Cape Colony, Natal, in the Eastern hemisphere, and Canada in the Western hemisphere, are all telegraphically connected with England. The importance and value to the Government of this connection is acknowledged, and hence there can be no hesitation in awarding the highest praise to the men whose business penetration and practical skill have achieved these results. Our submarine telegraph system—and when we use the word *our* we mean that of the whole world, for there is but one system—is practically the work of private companies, aided but slightly by governments. In fact, it may be questioned whether the work of governments has not on the whole been actually detrimental to the development of submarine telegraphy. We maintain that never before in the world's history has so vast an undertaking been so admirably systematised and adapted to the requirements of modern civilisation as has been the cable work of the past quarter of a century. The pioneers to whose conception we owe the system are still the foremost in perfecting that system, and we have no doubt can still see minor branches necessary before the whole is completed to their satisfaction. We trust that the success of the Cape cable will be such as to induce a prosecution of these designs, and that in the not far distant future it may be said there is no place in which the English flag is known that may not be in direct telegraphic communication with this country.

The commercial success of a cable is, as we have before pointed out, a peculiarly difficult problem to forecast. It depends on a large number of factors, the most important of which is the development of trade. Is the foreign trade with Africa capable of immense increase? Is the coasting trade likewise capable of increase? For upon the latter as well as upon the former depend the usefulness of the telegraph.

The recent explorations of various parts of the Continent all tend to show that immense tracts of fertile country are waiting the footstep of the trader. Hitherto the commercial undertakings, except in a few place, have been of a desultory character. The productions of these districts have been unknown, and hence there has been little or no demand. That trade will enter new channels we have little doubt, but whether the time of development will be long or short is a question of immediate interest to the directors of the new company. All the statistics at our disposal point to rapid progress.

The cable was opened to the public on Monday, Dec. 29. The few days' interval between the completion and the opening were utilised in giving the final touches to the arrangements, and in the transmission of congratulatory messages announcing the completion of the work.

The following, among other messages, have been transmitted by the cable:—

FROM THE QUEEN TO THE SULTAN OF ZANZIBAR.

The Queen congratulates the Sultan of Zanzibar on the opening of the telegraph line, and thanks him for his assistance in the completion of a work which she trusts will conduce largely to the interests of peace and civilisation in Africa.

FROM THE SULTAN OF ZANZIBAR TO THE QUEEN, WINDSOR.

The Sultan of Zanzibar has received Her Majesty's gracious message, and sincerely reciprocates Her Majesty's congratulations and good wishes for the civilisation and general welfare of Africa, to the attainment of which he will always use his best endeavours. He also hopes that the union by telegraph of Zanzibar with Her Majesty's dominions will knit still more closely the friendly relations which already exist between them.

FROM THE QUEEN TO SIR BARTLE FRERE, CAPETOWN.

I congratulate you on the completion of the telegraphic line between England and the Cape of Good Hope, and I rejoice in the more rapid means of communication and the closer connection thus happily established between this country and my South African Colonies.

FROM SIR BARTLE FRERE, CAPETOWN, TO THE QUEEN, LONDON.

Your Majesty's most gracious message, just received, is deeply appreciated by your loyal subjects in this colony. May the telegraphic line help to secure peace to Your Majesty's South African dominions in all coming years.

FROM THE QUEEN TO SIR GARNET WOLSELEY, NATAL.

I have much pleasure in congratulating you and the inhabitants of the colonies under your government on the completion of the line between England and South Africa.

FROM SIR GARNET WOLSELEY TO GENERAL SIR HENRY PONSONBY, WINDSOR CASTLE.

Pretoria, Dec. 27.

Kindly express to Her Majesty for me my sincere thanks for her gracious telegram of the 25th, which I received this afternoon. This signification of Her Majesty's congratulations, which I will communicate to the inhabitants of the colonies under my government, will be received in South Africa with the warmest welcome and gratitude.

The following replies have also been received from the King of Portugal and the Sultan of Zanzibar:—

FROM THE MARQUIS OF SABUGOSA, MINISTER OF THE COLONIES, LISBON, TO MR. PENDER, M.P., CHAIRMAN.

His Most Faithful Majesty commands me to signify to you

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how agreeable to him was the communication of the opening of the telegraph line to Natal, calling at Mozambique and Lourenço Marques, from Aden, thus remaining assured this international progress. His Majesty congratulates with you for such happy results of your efforts.

FROM THE SULTAN OF ZANZIBAR TO MR. PENDER, M.P., CHAIRMAN.

I thank you very much for the good wishes expressed towards me in your telegram to Dr. Kirk. I am very glad the cable is working well, and I wish the Company every success.

Messages were also sent to Dr. Kirk, Zanzibar; Sir Bartle Frere, Governor of the Cape of Good Hope; Señor Augosto de Castilho, Governor of Lourenço Marques; the Governor of Mauritius; Sir Garnet Wolseley, Commander-in-Chief, Natal; the Governor of Natal; Colonel Cunha, Governor-General of Mozambique; the King of the Belgians; Bishop Colenso, &c.

The management of the South African Cable Company includes, among others, the following gentlemen:—Mr. J. Pender, M.P., chairman; Sir James Anderson, managing director; Colonel T. G. Glover, R.E.; and Sir Daniel Gooch, M.P., and, if experience and energy were the sole requisites to success, we should say such a management would "command success."

1879.

Another year has flown, its experiences are numbered with the past, and we enter upon a new one full of hope that the immediate future will continue the increase of prosperity which the closing days of the old year have seen in this country. Revival of trade means really a revival of confidence, and capital long unemployed will find its way into remunerative channels. The use of capital productively is a benefit not only to the individual capitalist but to the country at large. Its influence is felt on every hand, and perhaps one of the most sensitive barometers to test the truth of revival or stagnation is the telegraphic system of the country. We are told that, according to this test, business *is* better. That this prosperity may continue, and that every one directly or indirectly connected with *The Electrician* may benefit from it, is our most earnest wish.

SUBMARINE TELEGRAPHY.—Our review of the year 1879 shall commence with this important application of electricity. As we have elsewhere stated, the CAPE CABLE was completed on Christmas Day. This cable was manufactured by the TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY. It connects our South African colonies with Aden, which place is one of the Eastern Company's stations, and is connected through their system with the mother country and the Eastern colonies. The cable consists of four sections, touching at the intermediate stations of Zanzibar, Mozambique, and Delagoa Bay. The entire length from Aden to Natal is 3,850 knots (4,438 miles). The shore ends and intermediate types of these cables are protected from the destructive action of marine insects by a sheathing of brass tape laid spirally round the core. The outside wires of the deep sea types are specially protected from deterioration by a chemically prepared tape being wound spirally round each separate wire. The ships employed in laying this important line were the ss. Scotia, 4,666 tons; Seine, 3,578 tons; Calabria, 3,325 tons; and Kangaroo, 1,773 tons. The first shore end was landed at Natal on the 5th July, and the final splice, as we have previously stated, was made off Zanzibar on Christmas Day.

Another important cable also manufactured by the TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY is the duplicate Australian cable. This is in four sections, touching at Malacca, Singapore, and Banjoewanjie, connecting Penang with Port Darwin. The total length is about 2,500 knots (2,882 miles). The shallow water and deep sea types are protected in a manner similar to the corresponding types in the South African cable. The ships employed in this work were the ss. Scotia, Edinburgh, 2,315 tons, and the Seine. It will be remembered that the magnificent ss. Scotia was visited by the delegates during the meeting of the International Telegraph Conference. The first shore end of this cable was laid at Penang on the 11th July, 1879, and the three sections completed to Banjoewanjie on the 9th December following. The Seine is on the point of proceeding with the laying of the final section to Port Darwin.

In addition to these, the same company has manufactured and laid a short line of 250 knots from Norway to the west coast of Sleswig, and has made a short cable 120 knots in length for the New Zealand Government. This last cable was shipped on board the ss. Kangaroo, which vessel sailed from Zanzibar on the 29th December to lay the cable between the north and middle islands of the colony. The total amount of cable manufactured by the TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY during the year was over 6,800 knots (7,839 miles), and the unfailing success which attends the work both as regards manufacture and laying is a proof of the great skill and practical experience which is brought to bear upon whatever this company undertakes. We believe the great secret of this success is that, notwithstanding its uniformity, no precaution is left unemployed to command success and avoid "chance" accident.

The INDIA RUBBER, GUTTA PERCHA, and TELEGRAPH WORKS COMPANY at Silvertown has performed some good work during the year, although not to so large an extent as the Company previously mentioned. The Caspian sea cable, about 147 miles in length, was manufactured by them for the Russian Government, and has been successfully laid. It would be interesting to have some detailed information as to the transmission of this cable from the factory to its ultimate destination. This Company also manufactured and laid the French-Algiers cable, a full description of which was given in Mr. March Webb's paper, read at the last meeting of the Society of Telegraph Engineers. The s.s. Dacia was employed on this service. The Silvertown Company, however, does not devote its sole attention to cable making, but manufactures all kinds of telegraphic apparatus, and here again we find the greatest attention paid to all details in order that the articles supplied should be perfect of their kind.

MESSRS. SIEMENS have manufactured and laid a new cable across the Atlantic, using the s.s. Faraday in this service. We are unfortunate in being unable to obtain any authentic information relating to this work. A description of the Faraday and her appliances for cable-laying, will be found in the proceedings of the Royal Institution, vol. vii., pt. iv., p. 310, by Dr. C. W. Siemens.

TELEPHONIC TELEGRAPHY.—The year may without danger be quoted as that in which telephonic exchanges were introduced into Great Britain. The rival systems are those of Edison and Bell. Let us take them in order. The establishment of the Edison Telephone Exchanges in London, Manchester, Liverpool, and Glasgow progresses steadily, and although the difficulties to be overcome in the matter of wire erection are much greater in English than in American cities, the experience of this Company is to the effect that the exchange system is meeting with quite as much success and

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favour as in its first introduction in America. Doubtless this may be due in large part to the fact of the demonstrated success of the system on the other side, as well as to the superior instruments and generally simplified character of the central exchange apparatus introduced on this side the Atlantic. The Edison Company is using a combination of Edison's Carbon Transmitter and Edison's Electro-Chemical Receiver, the most effective combination as yet devised, with which they are able to largely ignore the obstacles of induction, local noises, &c., &c., so fatal to other forms of telephone. The switching arrangements in use at their central stations are likewise a great improvement upon those in use in the United States, notably in the matter of reducing to a minimum the work and possible confusion in the exchange room incidental to the American exchange methods. This Company has purchased several existing telegraphic and telephonic plants upon which to engraft their telephone system; among these may be mentioned the Telegraph Exchange of Glasgow, numbering some hundred subscribers, a telephone private line system in Manchester, including pole lines to Bolton, Ashton, Droyesdale, &c., &c. Negotiations are pending, in a more or less advanced stage, for the introduction of the system in most of the principal cities of the kingdom. We are informed that the instruments now arriving from America are uniform in quality and show no perceptible deterioration after a prolonged transatlantic passage and many weeks of actual use. The engineer of the Company states that he is satisfied as to the durability of the chalk cylinder, which he believes to be practically indefinite. The Company using Bell's system has also been busily employed, and being first in the field has had an advantage over its rivals; having erected private telephonic communication for no less than forty-five firms, &c., in the metropolis, and having also a large number of subscribers. Exchanges on this system are said to work very well, and the demand for apparatus has been so large that the Company has been compelled to augment its staff. May both flourish; for the public will undoubtedly gain by the competition.

The Electric Light.—The work in this direction during the past year has been extremely important. While no startling discovery has been made—we shall refer to *The Times* and Edison presently—progress has been continuous. We long ago pointed out that the future of the Electric Light was more a question of perfection of details than of new discoveries. Improve the machine, improve the lamp, and every step will be a gain. We think, although the opinion may be wrong, that the Gramme machine only requires improvement in certain directions to make it almost perfect, and that the time spent upon attempts to discover something new will not be so well spent as in attempting to improve what we have. There are several men well known to us who could, and probably would, suggest improvements if any one with time and money would carry them out. As we say, some improvements have been made during the past year. The sole licensee for the Gramme machine here is the British Electric Light Company, 41, Parliament-street, E.C., and the experience of this Company during the year is worthy of record. We learn that, owing to the variety of demands springing up for these machines, the Company have produced some new classes of machines on the Gramme principle which are giving very satisfactory results. Several of these new machines—which have only been in existence a few weeks—have already been sold. Another important advance made by this Company is the acquisition of an arrangement for dividing the continuous current derived from the Gramme machines. This division is effected by aid of Blandy's patent magnetic governor coil, a very simple and inexpensive apparatus, which works with great success. Many firms have already used the "coil" with satisfaction. The old problem of *one machine and one lamp* is therefore very wisely disputed. One important feature in the British Electric Light Company's position is to be found in the fact that, while being in possession of the Gramme machine, they are not prejudiced as to any particular lamp, but use all approved lamps best adapted to meet their various requirements. Among the more important contracts carried out by this Company during the year may be mentioned the lighting of the Picton Reading Room, Liverpool; the steamship Mendoza; the North Shore Mills Co., Liverpool; the London and North Western Viaduct at Llandulas; the Milford Docks, South Wales; the Mersey Dock Works, Liverpool; and many others. With reference to the Picton Reading Room we noticed in a recent number of *The Times* that when the subject of the payment for the work came before the Corporation Committee the Liverpool borough engineer stated that the light as now applied was undoubtedly "a great success," while one of the members of the Committee said: "I think it is the most successful application of the light that has been seen in any part of England to the present time." With this testimony, we think the past year must have been a very satisfactory one in this country for the meritorious Gramme machine in the hands of the British Electric Light Company. We may add that the recent successful exhibitions of the light given by the Company in the St. Enoch's Station, Glasgow, have resulted in their contracting with the railway company for the continued lighting of this large railway station by electricity, supplied, of course, by Gramme machines. It is well known that the experiments on the Thames Embankment have been very successful. The number of lamps has been largely increased, and it has been found that the magnificient engine of Ransomes, Sims, and Company is capable of supplying the power requisite to drive the Gramme machines required for these lights. We have from time to time noticed the progress made, and thus may merely mention here that the engine and machines are stationed at Charing Cross Station, whilst the lights range from Blackfriars Bridge to the Victoria Station on the Metropolitan District Line. The rival of the Gramme machine is that of Siemens, but here again, as in the case of submarine cable work, we have been unable to obtain any information. In another column we notice an experiment with the Brush Machine and Lamp* recently introduced, but this introduction is not the only historical fact in this direction we can chronicle as regards English electrical work for 1879. The Lontin system, in fact, has been very successfully applied at the Aldersgate Street Station of the Metropolitan Railway by the Electric Generator and Light Company.

Mr. Edison's latest work in the direction of the Electric Light is thus described by *The Times* correspondent:—"Philadelphia, Dec. 28. Spending Saturday and Saturday night at Menlo Park with Mr. Edison, I thoroughly examined his inventions in electric lighting, comprising four particulars—generator, lamp, meter, and regulator—and providing, in my opinion, a complete substitute for gas. The light produced will be both cheaper and better than gas, being more regular, and emitting so little heat that there is no danger of fire. Some of his lights are purposely fixed amid the most inflammable material. I tried igniting paper by them, but the paper remained unscorched. About 60 lights were burning. On Saturday night I saw them burn seven hours. Two have

* For a description of the Brush Machine, &c., see *The Electrician*, July 12, 1879.

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been burning continuously for ten days without injury to the baked cardboard horseshoe in the little glass globe which furnishes the light. Cardboard seems sufficiently durable, successfully resisting quite rough usage, such as dropping, shaking, turning the current on and off thousands of times, and raising the intensity of light to that of 400 candles. All the arrangements are simple. Mr. Edison will put about 800 lights at Menlo Park, while the inventions immediately go into practical operation in New York city. The globe containing the horseshoe is exhausted to one-millionth of an atmosphere by the Sprengel pump, measured by the M'Leod gauge. By successfully dividing the electric current Mr. Edison gets individual lamps of 16-candle power, each lamp having 100 ohms resistance. Light is turned on or off and the current regulated with the same ease as gas is, while the current can be transmitted on wire as small as No. 36. The central regulator maintains an even current, while the meters accurately measure the supply furnished to each consumer. Mr. Edison finds that the best generators are of five to seven horse-power, each one horse-power maintaining eight lamps. Each lamp costs about one shilling to manufacture, while a supply equivalent to 10,000ft. of gas can be produced for tenpence or less. Mr. Edison calculates the cost of furnishing light thus—the consumption of 3lb. of coal in a steam engine will maintain eight to ten lamps one hour. Mr. Edison's system also furnishes electric power for small industries such as running sewing machines. Mr. Edison's light is bright, clear, mellow, regular, free from flickering or pulsations, while the observer gets more satisfaction from it than from gas. Mr. Edison lights at Menlo Park dwellings, offices, desks, street lamps, also laboratory and workshop, making it available for every lighting purpose for which gas is used. I ate my supper and wrote a draft of this telegram by Mr. Edison's light last night." This telegram supplied *The Times* with a subject for a leader. Our opinion, which is open to criticism, is that neither *The Times* reporter nor *The Times* leader writer understand the subject upon which they speak so confidently. We shall be glad to give Mr. Edison credit for all that he does when the work is proved, but we do hesitate to speak definitely even upon a subject with which we think we are tolerably familiar when so great pecuniary questions are involved. *The Times*, however, shows no such hesitation, and the gas shares are correspondingly sensitive. Plainly put, some one gains and some one loses for every share depreciated, and *The Times*—inadvertently, of course—plays into the hands of the speculators.

Discovery.—The palm must be given to Prof. Hughes for his induction balance. A description of this instrument will be found at p. 3, vol. iii. Since its discovery Mr. W. C. Roberts, F.R.S., has given special attention to its uses, and in his hands and those of Dr. Lodge we venture to think new uses and new theories will be developed. Mr. W. Crookes, F.R.S., has continued his researches on "Radiant Matter," a full account of which he gave in his British Association lecture, published in vol. iii.

Educational.—Among the signs of progress deserving of record are the action of the Society of Arts in devoting to telegraphy one series of Cantor lectures, given by Mr. W. H. Preece, M.I.C.E., and that of the City Guilds Institute, under whose auspices Prof. W. E. Ayrton has delivered a series of lectures on electricity and its applications. Papers and lectures of more or less value have been given before various societies, and among those not mentioned elsewhere of great importance we must place the lecture of Prof. Ayrton, at Sheffield, on "Electricity as a Motive Power," and the paper of Mr. J. N. Douglass, M.I.C.E., on "The Electric Light Applied to Lighthouse Illumination," to the Institution of Civil Engineers.

Patents.—It may be interesting to note here the history of electrical progress as exhibited by "patents." If the records of the Patent Office are examined, they will be found to give information somewhat as follows, under the following heads:—

Telegraphy—are recorded some	74	patents.
Electricity, Galvanism, Magnetism—applications of, to Motors, Galvanometres, Voltametres, &c., some ...	70	„
Electric Light	81	„
Magnetic Compasses.....	12	„
Electric Engines	4	„
Electrotyping	4	„
Signals	45	„
Total (about)	290	

This total may again be classified, so as to give some idea of the direction which the year's work has taken. It will be sufficient if we indicate a few of the most important directions:—

Under the head *Telephonic* are placed some ...	30	patents.
Telegraphy not telephonic.....	27	„
Telegraphy—Submarine.....	6	
Batteries	11	„
Electric Motors	6	„
Sounders	2	„
Insulation	10	„

It will be seen from these tables that the patents connected with the electric light still head the list, as was the case in 1878, and then comes telephonic apparatus. It is singular that so many worthless patents should be taken, for we are quite within the mark when we say that not one half these patents will bring the inventors the money invested in the provisional protection.

The Congress.—Our space, if not our material, is exhausted, and we can only refer to the fact that the International Telegraph Conference met this year at London. The work of the Conference is of the utmost importance to the well-being of most of our cable companies, hence the great anxiety as to its decisions.

CORRESPONDENCE.

THE TAY BRIDGE ACCIDENT.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: It does not seem very clear at present whether the bridge gave way before the train reached the fatal spot or whether the train was passing over it at the time of the accident. In order, however, to prevent the possibility of a train falling through a chasm in a bridge in future, would it not be better to have some automatic arrangement to inform the men in the signal cabins whether a bridge is perfect or not? I would suggest the following arrangement: The bridge itself might be made to form a part of an electric circuit. So long as the electric circuit was complete an electro-magnet could be made to attract an armature. If the circuit were to be broken by a portion of the bridge giving way, as in the late lamentable accident, the armature would be released, and might be made to set in motion an electric bell, and thus give timely notice to the men in the signal cabins or elsewhere to stop any trains from passing over the bridge.—Yours, &c., Charles Stewart, M.A.

50, Colebrooke-row, N., 31st Dec., 1879.

THE NEW FRENCH ATLANTIC CABLE COMPANY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Can you give your readers any information as to the new French Atlantic Cable Company? What has become of it? The 1st of January has passed, but without bringing with it the opening of their cable. What does this delay mean? Is it that the management is so at fault as not to have yet completed the

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arrangements for opening? or is the cable itself defective? or is it because the last instalment for the price to be paid for the cable not yet being paid, the contractors will not, therefore, part with it?

The fact is, this new company was not required; the public being already so well served by the existing companies, the shareholders of which may feel satisfied that the management of their property is such that their interests will be well protected in the coming contest, should that contest ever take place.

ONE INTERESTED IN TELEGRAPH PROGRESS.

1st January, 1879.

CONTRIBUTIONS TO A PHYSICAL THEORY OF ELECTRICITY.

BY DESMOND G. FITZGERALD.

(CONTINUED FROM P. 52.)

Momentum is the modern dynamical term which designates what was termed by Newton "quantity of motion," by Leibnitz "impetus," and by Maclaurin "force of a body in motion." The last expression is a peculiarly unfortunate one, and for more than a century and a quarter has been a prolific source of confusion and difficulty; for this reason I propose to revert to it presently. Momentum is measured by the product of mass into velocity; thus in foot-pound-second absolute measurement it is *mass in lb.* × *velocity in feet per sec.*: it is therefore equal to kinetic energy divided by half the velocity with which the body moves. If f be a force unopposed by another force, or acting freely to produce accelerated motion, we have:—

$$\text{Momentum} = m\,v = f\,t = \frac{2\,\mathrm{W}}{v}.$$

If ϕ be a force resisting motion or momentum, as for instance the weight of a mass ($m\,g$), we have:—

$$\text{Momentum} = m\,v = \phi\,t = m\,g\,t.$$

From this it follows that momentum is measured by the constant or mean force which will overcome it in *unit time*, or by $\phi = m\,v$. Thus, supposing a mass of ten pounds to be moving horizontally with a velocity of 100 ft. per sec., the resisting force which would overcome the momentum in 1 sec. is $\phi = 1000$. If the resisting force be the weight of a mass, then $\phi = m\,g = 1000$; and, if we take g as 32·2, $m = \frac{1000}{32{\cdot}2} = 31{\cdot}056$ lb.—this being the mass of which the weight would overcome the given momentum in 1 second of time. The latter statement may be readily proved by calculating the kinetic energy of the moving body and the work done on the mass m in the unit time—quantities which must be equal if the statement be correct. Thus, the energy is

$$m\frac{v^2}{2} = 50{,}000 \text{ absolute units,}$$

$$\text{or} \quad \frac{50{,}000}{32{\cdot}2} = 1552{\cdot}8 \text{ foot-pounds.}$$

The former value should express $m\,g\,s$, and the latter $m\,s$; thus the space moved through vertically by the mass m should be

$$s = \frac{1552{\cdot}8}{m} = 50 \text{ feet.}$$

This is correct, since

$$\phi\,s = m\,g\,s = 1000 \times 50 = 50{,}000 \text{ abs. units of work,}$$

and by (VI.),

$$t = \frac{2\,s}{v} = \frac{100}{100} = 1 \text{ second.}$$

With reference to Maclaurin's expression "force of a body in motion," we have seen that this may be represented by $\phi = \frac{m\,v}{t}$ *when time is specified.* But, when the *space through which* ϕ *is overcome* by the momentum is specified, we have—since $\phi\,\mathrm{S} = m\frac{v^2}{2}$,

$$\phi = m\frac{v^2}{2\,\mathrm{S}}$$

as an expression for the force of a body in motion; so that in this case, when S is unity, the force is measured not by momentum but by kinetic energy. If neither time nor space be specified, it is impossible to say what is the "force of a body in motion": it may be indefinitely great or indefinitely small, according to conditions. Thus let $f\mathrm{S}$ express the kinetic energy stored up in a hammer at the time it strikes a blow upon a nail; let ϕ be the mean resistance opposed to the driving of the nail; and let s be the space through which it is moved by the effect of the blow. We have then $f\mathrm{S} = \phi\,s$; and, however great may be the resistance ϕ, it will be overcome by "the force of the moving body." If s, the space through which ϕ is overcome, be indefinitely small, or if $s = 0$, then we must have $\phi = \frac{f\mathrm{S}}{0} = \infty$. The "force of a body in motion" may therefore be said to be irresistible: it measures and is measured by momentum only when it acts during unit time. Otherwise, it is measured by $\phi = \frac{\mathrm{W}}{s}$.

In the case of uniformly accelerated *resisted* motion, we have:—

$$a = \frac{f-\phi}{m} = \frac{f_l}{m} \text{ (acceleration),} \quad \ldots \quad \text{(V}a\text{.)}$$

$$f_l = f - \phi = a\,m \text{ (accelerating force)} \quad \text{. (IX.)}$$

and

$$v = a\,t = \frac{f_l}{m}t = \frac{f-\phi}{m}t. \quad \ldots \quad \text{(X.)}$$

Then

$$\text{Momentum} = m\,v = m\,a\,t = f_l\,t = (f-\phi)\,t.$$

It should here be noted that, the nearer the ratio $\frac{f}{\phi}$ approaches unity, the more nearly does the value $m\,v$, multiplied into ϕ, express the work done in unit time. Thus when a man uses a windlass to raise a heavy mass, in which case $\phi = m\,g$, the work done in unit time is very nearly expressed, in gravitation measure or *foot-pounds*, by $m\,v$, or the momentum obtained after a short period of time. Nor is it necessary, for this to be true, that the ratio $\frac{v}{m}$ should be comparatively small: a high velocity may first be obtained by a high value for $\frac{f}{\phi}$; and this ratio may then be diminished until the accelerating force $f-\phi$ is very small, although the acquired velocity is maintained; in this case $m\,v$ will nearly express the work done in unit time.

The preceding observation brings us to the case of *uniform motion*, which it is our main object to study. Here it is very important to note that, since $v\,t = s$, $m\,v$ *accurately* expresses in gravitation measure the work done in unit time when $\phi = m\,g$, and, generally,

$$m\,v\,t\frac{\phi}{m} = v\,t\,\phi = \phi\,s = \mathrm{W} \text{ (in absolute units).}$$

Or, when $\phi = m\,g$,

$$m\,v\,t\,g = m\,g\,s = \mathrm{W} \text{ (in absolute units),}$$

and

$$m\,v\,t = m\,s = \mathrm{W} \text{ (in foot-pounds).}$$

In what has already been said, the student may find some grounds for the conclusion, hereinafter to be more definitively established, that *in uniform motion the force* (f) *which produces the motion is always equal to the force* (ϕ) *by which the motion is resisted*, or that, in this case, we have

$$\frac{f}{\phi} = 1, \text{ or } f = \phi.$$

And, again, since $s = v\,t$,

$$f\,t = \frac{f\,s}{v}; \text{ or, } v \text{ being constant, } f\,t \propto f\,s.$$

It has by some been considered that, as *momentum* does not involve the "principle of work," it is an unnecessary dynamical value, a mathematical rather than a physical expression. To my mind it appears, in the first place, not unnecessary because it is a very useful quantity. Thus, knowing that the same force (f_l), in a given time, produces the same momentum whatever may be the mass it acts upon to produce motion, we know, without any calculation, that the momentum obtained by a shot, when fired from a gun, must be exactly the same as that obtained by the gun and its carriage. And, when an inelastic body in motion strikes another inelastic mass at rest, we know that the two masses will move with a joint momentum equal to that which was possessed by the former body, and we can readily calculate, therefore, the quantity of kinetic energy converted into heat by the collision. In the second place, the fact that momentum undoubtedly expresses *quantity of motion* has an important physical significance, indicating as it does that the total energy in the universe cannot be expressed by the total, actual and potential, quantity of motion.

Vis viva is the term used by Leibnitz to designate the value $m\,v^2$, by which, instead of by $m\,v$, he estimated the "force of a body in motion." The reader of these papers will understand that, as was pointed out by D'Alembert, the controversy respecting the measure of "moving force" was merely a verbal one; the uniform force that would act during unit *time* being measured by $m\,v$, and that which would act through unit *space* being measured by $m\frac{v^2}{2}$, according to the absolute systems of measurement usually adopted, or by $\left(\frac{v}{2}\right)^2 = \frac{v^2}{4}$ according to the system exhibited in Appendix I. The latter values measure

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also what is now termed kinetic energy; so that, according to the usual dynamical systems, *vis viva* is, arithmetically, *twice the kinetic energy*. The value mv^2 cannot conveniently be brought into any system of absolute measurement; and there is consequently, so to speak, no room for the term *vis viva* in modern dynamics; its abstract meaning being better expressed by kinetic energy.

Mass or *quantity of matter*, in the absolute systems of measurement, is expressed in pounds, grains or grams; these being *units of mass*, and not *units of weight* as is often erroneously supposed. Indeed in the gravitation system also, when, for instance, the *pound* is adopted, mass should always be expressed in pounds, and not by pounds $\times$ g, which value represents the *weight* of the mass in absolute units of weight, or by $\frac{\text{pounds}}{g}$, which value indicates that the pound has been taken as the unit of weight. In mechanical dynamics no distinction is made between various kinds of matter, and *mass*, or quantity of matter, is altogether independent of *weight*. Practically, however, masses are compared by their weights at the same latitude and height above the sea-level. I know only of two absolute methods of measuring mass; these involve respectively *momentum* and *kinetic energy*. In one of these, mass is measured by the accelerating force (f_l) which will produce unit velocity in unit time; in the other it is measured by twice the kinetic energy stored up in it when it is moving with unit velocity. These methods are dependent upon the equations

$$m\,v = f_l\,t\,;\ \text{whence}\ m = \frac{f_l\,t}{v},$$

and

$$m\frac{v^2}{2} = f_l\,s = W\,;\ \text{whence}\ m = \frac{2\,f_l\,s}{v^2} = \frac{2\,W}{v^2},$$

if W be the number of work-units equivalent to the kinetic energy.

It is hardly necessary to say that the momentum or kinetic energy of a pound of hydrogen in motion would be precisely the same as that of a pound of iron or lead moving with the same velocity.

We can readily conceive of the existence of ordinary matter under conditions in which it would have no weight, properly speaking, although its parts would gravitate to each other. But, further, the physicist is called upon to admit at least the *possibility* of the existence of forms of matter which either are not subject to gravitation, or are subject to the operation of forces which render it practically impossible to exhibit their weight; since it would be very rash to assert that nothing can be matter or possess mass which cannot be weighed. The *gratuitous* assumption of the existence of "imponderable fluids," in order to account more or less plausibly, or more or less clumsily, for any phenomena of which the causation may seem obscure, is altogether opposed to the spirit of inductive research, and is as repugnant to my mind as it can be to that of any other investigator. But, on the other hand, if valid and substantial grounds can be adduced to show that any measurable quantity is possessed of some of the distinguishing attributes of matter, and, further, that it possesses none of the characteristics of a mode of energy, then it is most unphilosophical to regard it as being merely a mathematical value, and to ignore its existence as an actual entity. I consider that electricity is such a measurable quantity; and I may mention that I have been enabled to satisfy my own mind as to the probability of the existence of other forms of matter which, if exhibited, might be loosely designated as "forces" or "modes of energy." For the present, however, I must confine myself to a question which legitimately comes under the present heading.

Supposing we have a measurable quantity which is not susceptible of being weighed, how can we determine:—(*a*) whether it is a purely mathematical value, (*b*) whether it is a mode of energy, or (*c*) whether it is a form of matter?

(*a*) The first question may, without much risk of material error be answered very briefly. A purely mathematical value cannot be exhibited either as a force, a mode of energy or a form of matter. Thus *momentum*, which, under certain conditions, can be expressed as a force, is not a purely mathematical value; but $\sqrt{v}$, π, tan. 60°, log. g, and (as I propose to show) the electrical quantity E come under this category.

(*b*) If the measurable quantity be a mode of energy, it must necessarily have a mechanical equivalent, susceptible of being expressed in foot-pounds or in any absolute units of work. Moreover it must be convertible into heat, and into other modes of energy. In the present position of science, it has been shown, and it is not very difficult to show, that every mode of energy or motion, not even excepting light, tends to pass into that mode of motion which we call heat, and thus to become converted into potential energy.

(*c*) If the quantity be a form of matter, it is acted upon by force and constitutes a *vehicle for energy*, with which and from which it may alternately be associated and disassociated. But its conversion into energy or into any mode of motion will be a matter of absolute impossibility, and, consequently, it can have no mechanical equivalent, or will not be susceptible of being expressed in terms of any unit of work. Regarded from a chemical point of view, its attractions or affinities may be satisfied by combination or intensified by separation; but, whatever may be its potential energy, it is in itself inconvertible, and retains certain properties which are inherent to itself. When in motion it must necessarily possess momentum and kinetic energy, and when at rest it may be influenced by forces capable of acting upon it through certain distances, and thus giving to it a certain energy of position. Whilst it is susceptible of combination, and of association with variable quantities of energy, its most essential characteristic is its inconvertibility; whereas that of energy is its convertibility.

(TO BE CONTINUED.)

LITERATURE.

SCIENCE MANUALS.

Elementary Mechanics, including Hydrostatics and Pneumatics. By OLIVER J. LODGE, D.Sc. Lond., &c. W. and R. Chambers, London and Edinburgh.

So many elementary treatises have been recently written that the first question which arises when one sees a new one is—was the book written because there was a literary void that it was desirable to fill up, or merely because there was a man who felt himself compelled to write something or other? Let the author speak for himself; he says:—"The non-mathematical English works on Mechanics are mainly of two kinds—one the old-fashioned text-book, which every one now feels to be quite unsatisfactory, and the other, the comprehensive and powerful productions of Professors Thomson and Tait, Clerk Maxwell, and W. K. Clifford, which, though not confessedly mathematical, are yet far too difficult for beginners." He then explains that it has been his object to write a book which, as far as it goes, shall not be less exact, or less scientific, than the larger works previously referred to. Next follows a paragraph which removes altogether any doubt that may have existed in the reader's mind as to the reasons for which the book was written:—"The statements made in a book should be carefully criticised and not taken for granted—and all kinds of special cases should be thought of or tried, to see if an exception cannot be found. *It is by thinking one's-self on a subject that it becomes really known to one's-self; it will never be really known if we only try to understand and remember what the book says.*" We feel tolerably sure that a man who writes such a paragraph as this in the preface to his book must have practiced what he preaches, and if so, that his elementary text-book must be vastly superior to previously existing ones.

It might, perhaps, at first sight appear that a review of a work on mechanics was unsuitable for an electrical periodical; but if it be remembered that a proper text-book—one like that we are considering—deals not merely with tooth-wheels, pulleys, &c., but with the general principles of energy, it will be seen that the ideas developed in it are as important to the electrician as to the makers of steam engines; for a right understanding of the laws of energy is a necessary preliminary for the comprehension of the absolute system of electrical units, and for the proper appreciation of what has recently been written—much of it wrong, some of it right—by practical men about the electric light.

We could have wished that Dr. Lodge, with the boldness of character that allows him to suggest such expressions as "four speeds a second," so many "hurrys per minute," had dropped the old name mechanics, and called his book by some title, suggested by himself, expressive of the fact that it constituted an introduction to the science of energy,—"energetics" we hardly like to suggest, as it is not euphonious enough; for we are afraid that the old name mechanics, under which so much at the present day is being classed by the world at large, is hardly comprehensive enough, unless, indeed, it be assumed that we are gradually approaching a science of the mechanics of molecules, which will, of course, include all sciences. But, naturally, the publishers of a cheap book must study the public taste, and while giving us the cake, the plums, and all the good things inside, must call it by a name that suits the language of that terrible taskmaster the examiner.

One stumbling block in the old books on mechanics, and one beautifully contrived to trip up even a wary beginner, was the use of the two expressions *moving force* and *accelerating force;*

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the first to express a force, the second to designate what was not a force at all, but a quickness. The English student was, we believe, freed from this nightmare about 1866. The next ingenious device to be got rid of was the unmeaning expression *virtual velocity*, a roundabout way of speaking of work, and which always appeared like a species of conjuring—a hey-presto method of arriving at a result. Certainly many students worked innumerable problems in virtual velocities without the grand principle of the conservation of energy ever dawning on them. In the treatise of Dr. Lodge's before us there is much said about work, much about motion and energy, &c., but what a gasp of relief we gave in not meeting with the expression *virtual velocity*.

Again we open at random the book at page 44, and find the complete distinction between "weighing" and "massing" clearly and well explained, which is, perhaps, the third confusion in mechanics science wants to see cleared off.

When we read this book of Dr. Lodge's we have another example of those waves of intellectual progress which, starting from the Scotch Universities, have rolled on to London. With Prof. Fleeming Jenkin's book on "Electricity and Magnetism," published in 1873, the electrical wave reached us. One began to speak then of potential without feeling incomprehensible or pedantic; one began to feel the vast power that was contained in the exact study of the electrical science. Now it will be their own fault if even those who know but little mathematics do not grasp the fundamental principles that govern all physics, viz., that of the conservation and dissipation of energy, for the wave of accurate mechanical knowledge which commenced to arrive some years back may now, by means of Dr. Lodge's book, reach the minds even of beginners. At length we are prepared to assert, in spite of the examiner, that questions on the wheel and axle, the inclined plane, &c., should be regarded chiefly as examples of the fundamental principles of work, and that it is to these principles the attention of the students should be mainly directed, the mere formulæ for the mechanical advantage of certain simple bits of imaginary machinery being no longer regarded as magic sentences of wonderful import.

In the general plan of this series of books issued by Messrs. Chambers it is stated that the treatment will be found to meet the requirements for the examinations held by the Science and Art Department. We venture, however, to think that if all the books of this series are like the one before us that they will do something more than merely meet the requirements of these examinations, they will rather form the groundwork on which the examiner will base his questions.

It has often been objected to the Science and Art Department that those who attend science classes do not find any great ease in learning their trade. This objection, which is quite a true one, arises, of course, from the vague way in which the student at such classes is acquainted with scientific principles, from the wide gulf that exists between the acquisition of these scientific principles and their direct application to any special trade, &c. Now, however, that the City Companies of London are seeing the importance of furnishing the means for imparting to boys and girls technical education (that is, instruction in the *application* of scientific principles to the manufacturing industries), after they have learnt something of pure science, and before they are apprenticed to their trades, it becomes of the highest importance that the groundwork in pure science the young students acquire shall be a solid one. Consequently, we cannot but give a most hearty welcome to any book like that of Dr. Lodge, which is very simple and at the same time perfectly sound.

TRAFFIC RECEIPTS FOR NOVEMBER, 1879.

Companies.	Nov. 1879.	Nov. 1878.	Increse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	3,000 estd.	2,609	491	—
Direct Spanish Telegraph Company	1,334	1,002	332	—
Direct United States Telegraph Company	—	—	—	—
Eastern Telegraph Company	46,147	37,170	8,977	—
Eastern Extension Telegraph Company	26,379	25,280	1,099	—
Great Northern Telegraph Company	16,653	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—

Something Like a Premium.—As we are going to press, we hear from New York that the shares of the Edison Electric Light Company, of one hundred dollars par value, are selling at three thousand dollars per share.

TELEGRAPH SHARE LIST.

Companies.	Closing Prices Dec. 31.		Business Done Week Ending Dec. 31. Highest.		Lowest.	
Anglo-American Ordinary	57½,	¾	57¾		56⅝	
Do. "B"	82,	½	82⅝		82¼	
Do. "A"	32¾,	3½	33⅛		32⅛	
Brazilian	7 9-16,	11-16	7 11-16		—	
Cuba	8½,	9	8¾		8⅝	
Do. Ten per Cent. Preference	15½,	16½	—		—	
Direct Spanish	2¼,	¾	—		—	
Do. Ten per Cent. Preference	12,	½	—		—	
Direct United States	10⅜,	⅝	10⅞		10⅜	
Eastern	8 7-16,	9-16	8 9-16		8⅜	
Do. Six per Cent. Debenture	102,	4	—		—	
Do. Five per Cent. do	102,	4	102¾		102¼	
Do. Six per Cent. Preference	11¾,	12	—		—	
Eastern Extension	8 7-16,	9-16	—		—	
Do. Six per Cent. Deb.	106,	109	—		—	
German Union	8½,	9	8¾		8½	
Globe Telegraph and Trust	5 1-16,	3-16	5 3-16		5	
Do. Six per Cent. Preference	11½,	½	11½		11½	
Great Northern	8½,	¾	9 3-16		9 3-16	
Indo-European	22½,	3½	23½		23½	
Mediterranean Extension	2¾,	3½	—		—	
Do. Eight per Cent. Preference	10,	½	—		—	
Reuter's	10,	11	—		—	
Submarine	227,	33	231		231	
West India and Panama	1½,	¾	1 9-16		1 9-16	
Do. Six per Cent. Preference	7⅜,	⅝	7⅝		7⅜	
Western and Brazilian	5⅜,	⅝	5⅝		5⅜	
West. Union Seven per Ct. 1st Mt.	120,	5	—		—	
Do. Six per Cent. Sterling	105,	7	106		105	

ADDRESSES.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

PETER BROTHERHOOD, Engineer, 56 and 53, COMPTON-STREET, GOSWELL-ROAD, E.C.
Specialities—Patent 3-Cylinder Engines (Silver Medal, Paris), as used by Siemens, Gramme, and Wilde for driving Electric Machines.

RANSOMES, SIMS, and HEAD, Orwell Works, IPSWICH.
Specialities—Portable and Stationary Engines, fitted with patent governors, as tried in the electric lighting experiments on the Thames Embankment.

ABBOTT and Co., NEWARK-ON-TRENT.
Specialities—The "Standard Size" Vertical Cross Tube Boilers. Illustrated catalogue, giving every detail of a variety of Boilers, 2s. 6d., post free.

CARBON ELECTRODES COMPANY. Works: 39, COMMERCIAL-ROAD, EAST.
Specialities—Carbon Rods of all sizes for Electric Lighting. Also, Plates and all other Moulded Carbon Goods. List of prices on application.

M. THEILER & SONS, Telegraph Instrument Manufacturers, 86, CANONBURY-ROAD, N. Works: ALWYNE-LANE, N.
Specialities—Morses, Polarised Relays, Saunders' Curb Keys, Type Printers, Recording Sounders, Duplex Apparatus (Theiler's Patent).

THE BRITISH ELECTRIC LIGHT COMPANY (Limited), 41, PARLIAMENT-STREET, WESTMINSTER, and 17, WATER-STREET, LIVERPOOL.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

HOOPER'S TELEGRAPH and INDIA RUBBER WORKS, MITCHAM and MILLWALL DOCKS.
Contractors for the Manufacture and Laying of Submarine Telegraph and Torpedo Cables. Manufacturers of Hooper's celebrated Insulated Core. Printed reports on application. Offices: 31, LOMBARD-STREET, LONDON, E.C.

ELECTRIC LIGHT APPARATUS.—To be SOLD at a considerable reduction in price, ONE SIX-LIGHT GRAMME ELECTRIC MACHINE, alternating current, SIX JABLOCHKOFF LAMPS, ORNAMENTAL IRON LAMP COLUMNS, &c., in excellent condition. Have been used a very few nights.—Address X., care of MARTINEAU and SMITH, Birmingham.

INSULATED WIRES.—A large quantity of GUTTA PERCHA and INDIA RUBBER COVERED WIRES, various sizes, for SALE considerably under cost.—A. VEREY and Co., Dover.

AN experienced Civil Engineer seeks an appointment as MANAGER of an ELECTRIC LIGHT COMPANY in England or abroad. Address Mr. MARTIN WILLS, 9, Portland-terrace, Regent's Park, N.W.

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SLIP

ADVICE GRATIS TO SHAREHOLDERS.—Whenever shares are thirty times the par value, sell.

WEST INDIAN CABLES.—The cable between Santa Cruz and Trinidad, made of Hooper's core, and laid in 1875, is interrupted; so, also, is that between St. Thomas and St. Kitts.

GERMAN UNION TELEGRAPH COMPANY.—Notice is given that an interim dividend of 11s. 9d. per bond will be paid on and after January 6, at 66, Old Broad-street, and 4, Werderstrasse, Berlin.

LONDON BRIDGE.—There is some idea of adopting the electric light for illuminating this bridge. The sooner the idea is put into effect the better, for a more important improvement can hardly be conceived.

MEMORIAL TO CLERK MAXWELL.—It has been decided to create a memorial to the late Professor Maxwell, but the form has not yet been settled. It will probably take the form of a scholarship for some specified research.

EASTERN TELEGRAPH COMPANY.—Notice is given that an interim dividend of 2s. 6d. per share on the ordinary shares and of 3s. per share on the preference shares will be paid on the 14th January. The transfer register of the Company will be closed from the 7th to 14th January.

TELEPHONES IN BRAZIL.—Telephonic communication has been established among many of the large plantations, different private parties, and Government offices. At Rio de Janeiro Gower telephones are used for sending messages between the Senate and the Lower House.

TRIALS OF ELECTRIC LAMPS.—Comparative trials have been carried out in Paris between the Jablochkoff candle and the Werdermann lamp, and also the Jablochkoff candle and the lamps of Lontin and Siemens. The Werdermann was found to be steadiest, and the Jablochkoff most powerful.

GAINSBOROUGH.—The directors of the Gainsborough Gas Company have expressed their willingness to sell the works to the local board of the town for £42,000, with a reservation that the board may throw up the bargain within a twelvemonth if they feel inclined to place their trust in electricity.

MILITARY TELEGRAPHY.—A school for obtaining a knowledge of military telegraphy has recently been inaugurated in Berlin. So far as we are aware, there is only one book published which treats exclusively of military telegraphs, and this is a German work by M. Truenfeld. We shall shortly notice this work at some length.

ANOTHER USE FOR ELECTRICITY.—It is suggested that some practical work should be done by the crews of torpedo-vessels in attacking icebergs. Of course the work would be more exciting than firing at dummies, and the results could be better estimated. The suggestion might be extended, and results of the action of various explosives ascertained.

THE CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of the Cuba Submarine Telegraph (Limited) during the month of December was 2,637, estimated to produce £3,000, against 2,664 messages, producing £3,095, in the corresponding month of last year. The traffic receipts for the month of October, estimated at £3,000, realised £3,512.

THE BELL TELEPHONE EXCHANGE.—Considerably over 200 subscribers now enjoy the facilities of the Coleman-street central exchange. Local exchanges have also been opened in Leadenhall-street, and Palace Chambers, Westminster. The provincial towns, Manchester, Liverpool, Birmingham, Sheffield, Bristol, Leeds, Edinburgh, Glasgow, and Dundee have also been provided with exchanges.

AN OBSERVATORY IN CYPRUS.—The establishment of an astronomical, magnetic, and electric observatory on one of the mountains of Cyprus has been advocated by Prof. Piazzi Smyth, the Scotch Astronomer Royal. The clear skies of that island as compared with our own cloudy atmosphere would eminently fit it for such a purpose. Let the old gods give place to helioscopes and instruments of precision, Jove's thunderbolts to Thomson's quadrant electrometer.

LIGHTNING ACCIDENT AT ASHFORD SCHOOLS.—On Tuesday week last, during the violent storm, the lightning struck the conductor attached to the engine-house chimney shaft of the West London District Schools, and tore it completely away from the building. Had the shaft not been so protected the consequences would have been very serious. It would be advisable for all owners of shafts, &c., to examine their lightning conductors to see that the earth contact is good.

THE ELECTRIC LIGHT IN LIGHTHOUSES.—The United States Lighthouse Board is desirous of making experiments to test the relative merits of electric lights for their particular service, and an appropriation of 50,000 dollars has been asked for the purpose. Strange to say the Americans have no lighthouse fitted with the electric light yet. We may also add that the same board have asked for 50,000 dollars to supplant the old light ship off Sandy Hook by a new one fitted with a steam fog signal.

NOVEL ADVANTAGE OF THE ELECTRIC LIGHT.—The other evening, in Liverpool, a Miss M'Goldrick, and a party of friends, went shopping in Ranelagh-street, and on alighting from their carriage a thief, watching his opportunity, while they were in conversation opened the lady's satchel, and abstracted a purse, containing between £50 and £60. Owing to the brilliancy of the electric light one of the party, seeing the act, seized the thief's hand and secured the purse. In the confusion the thief got clear off.

LONG RANGE TELEPHONING.—The details of the reported long range telephoning by Edison's telephone turn out to have been slightly incorrect. The message was actually telegraphed from Mr. Packer in Nebraska to Manch Chunk, Philadelphia, and thence to Mr. Packer's office at Sayre, from which place it was telephoned to Mr. Packer's house. The slight error of the newspaper men amounts only to about 1,999 plus a fraction miles. It would be captious to criticise this little inaccuracy too severely.

THERMO-ELECTRIC STEEL TESTS.—Carl Barus has studied the thermo-electric disposition and the electric conductivity of steel, in their relations to the hardness of the steel. He finds that if a steel rod of uniform known hardness is broken in two, and the two original ends connected with a galvanometer, the hardness of pieces of steel can readily be tested. For, if the free ends of the test rod are laid on the sample of steel which is to be tested, and either point of contact is heated (*e. g.*, with a small jet of steam), the thermo current will flow from the test rod if it is harder, and to the rod if it is softer than the sample.

ELECTRICAL APPARATUS IN DIVING OPERATIONS.—The officials of the North British Railway Company at Dundee during the past few days have been inundated with letters containing suggestions of all kinds as to the best means of

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recovering the bodies of the passengers. Mr. F. W. Pope Cox, of the Telephone Company, has kindly offered the use of a set of telephones (Bell's) for communicating between the shore and the divers' barge. It has also been suggested that the use of electric light apparatus would facilitate the operations. Several systems can be used under water. We imagine, however, that the operations are impeded by tempestuous weather more than by the lack of appliances.

Artificial Diamonds.—In a recent note we mentioned that Mr. Mactear, a Glasgow chemist, had announced his success in making diamonds. That gentleman has further protected his process by means of a patent taken out last month. It now appears, however, that Professor Maskelyne, the eminent mineralogist, has pronounced against the genuineness of the specimens submitted to him. These were so small as to be in reality mere dust, and they failed alike in scratching topaz, in glowing under the blow pipe, and in resisting the action of hydrofluoric acid. Mr. Maskelyne has therefore no hesitation in asserting that they are not diamonds or carbon at all, but some kind of crystallised silicate, and that the problem of transmuting black carbon into transparent crystals is still unsolved.

An Ear-Fitting Telephone.—The *Scientific American* illustrates a double telephone intended to clasp round the head of a person and fit over both his ears. It is the invention of Mr. Andrew C. Hubbard, of Danbury, Conn., and consists of two small bell receivers of peculiar construction, connected by a curved hoop, which goes round the back of the head. Each ear-telephone consists of a Jamin laminated horse-shoe magnet, combining great power with little weight. The ends of the magnet are cut off diagonally, and the poles are each surrounded with a helix of fine wire. The diaphragm is placed in front of the poles; but an improvement is introduced in the shape of a triangular armature of soft iron fixed to the diaphragm and fitting in between the poles of the magnet, which are sliced off at a corresponding angle to each other. The ear piece is shaped like a squat funnel, the nozzle being inserted in the orifice of the ear.

A New Use for the Telephone.—In the United States a series of experiments has been made by the Ordnance Department in the use of the telephone to assist in determining the time of flight of small-arm projectiles, which has hitherto been a matter of great difficulty at long ranges, owing to the impossibility of seeing them strike. One telephone was placed within a few feet of the gun, and the other (both being provided with Blake's transmitters) in the shelter, about 30 feet in front of the target. The telephone being placed to the ear, a stop-watch, beating fourths of a second, was started at the moment of firing, and stopped on the bullet striking. The observations founded on a large number of experiments never differed more than a quarter or half of a second from each other, the slight delay in starting the watch being neutralised by the delay in stopping it. It was found that the time of transit was affected by the wind, being shortened by a rear and lengthened by a head wind.

Cold and Magnetism.—In a paper read before the Geological Club at Dulwich College, Mr. B. G. Jenkins, F.R.A.S., gave some reasons for believing that the weather of the future might be placed on some sort of scientific basis. It has been frequently remarked that we import our weather from America as if it were so much corn, and it is an undoubted fact that much of our weather comes from the other side of the Atlantic. Mr. Jenkins said he had observed an evident connection between it and the fact that in this same quarter there is a superabundance of magnetism, and that the poles of cold and magnetism are to be found near each other. He believed that he had established beyond doubt, in a paper which had appeared in the transactions of the Roman Academy, that there are two vast atmosphere magnetic bands in the northern hemisphere which, through cosmical influences, affect the cold upper regions and periodically drive down waves of cold of more or less lengthy duration, to be followed by abnormal heat. It has been observed by meteorologists that no such cold period as the present has occurred for about eighty years, and it is somewhat remarkable that no such period of magnetic tension has happened since the close of the last century.

The Proposed Electric Standard of Light.—We took occasion recently to mention Mr. Schwendler's proposal to form a new standard of light by bringing a ribbon of platinum into a state of incandescence by means of the electric current. But this is really an old plan suggested by Dr. John Draper in the *Phil. Mag.* for November, 1847, where he says, "Among writers on optics it has been a desideratum to obtain an artificial light of standard brilliancy. The preceding experiments furnish an easy means of supplying that want, and give us what might be termed a unit lamp. A surface of platinum of standard dimensions, raised to a standard temperature by a voltaic current, will always emit a constant light. A strip of that metal one inch long and one-twentieth of an inch wide, connected with a lever by which its expansion may be measured, would yield at 2,000° a light suitable for most purposes. Moreover, it would be very easy to form from it an available photometer by screening portions of the shining surface. An ingenious artist would have very little difficulty, by taking advantage of the movements of the lever, in making a self-acting apparatus in which the platinum should be maintained at a uniform temperature, notwithstanding any change taking place in the voltaic currents." It may be remembered that Mr. Preece cited these remarks in one of his earliest lectures on the electric light last year.

Telegraphers' Conviviality in Swansea.—On Monday the annual dinner of the telegraphists of this town was held at the Castle Hotel. Mr. D. Snell occupied the chair, and Mr. D. Orrin the vice-chair. Amongst the visitors present were the mayor, John Jones Jenkins, Esq., Mr. Z. Evans, Pontardawe, and other gentlemen. The Mayor, in reply to a toast, referred at length to the great usefulness of the electric telegraph, and the very long and rapid strides it had made, particularly in Swansea. Mr. Z. Evans proposed "The Swansea telegraph staff," coupling the name of Mr. P. Smith. He passed a very high compliment upon them, and considered them as a body of officials second to none in the kingdom. Mr. Smith responded on behalf of the staff. He said that although their modesty would not permit them to have such a high opinion of themselves, yet they always endeavoured to do their duty to the best of their ability, and had often won very valuable praise. He also referred to the recent lamented loss of two members of their staff, viz., Mr. Chas. Grinter and Mr. D. Williams. "The Swansea Telegraph Superintendent" was proposed by Mr. W. W. Howell, with musical honours, and responded to by Mr. D. Snell, who thanked the company for their kind appreciation of him and his staff for their courteousness and willingness throughout the year, and hoped to be spared to be long with them. We should be glad to hear more of the social meetings of our friends.

Explosion of a Yankee Notion.—Professor Wingate claimed to be the inventor of an apparatus with which he

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could destroy a vessel at a distance of five miles. This would, he reasonably said, put a stop to all naval warfare, since anybody in possession of his secret could shatter a hostile fleet without getting within range of its guns. He gave a public exhibition at New Orleans two years ago in the presence of many scientific men. The hulk of a schooner was operated upon. The Professor approached within about a mile of it in a small boat, and then it was blown to atoms. As to the nature of this awful force, he would only say that it was electricity, applied without any direct connection between the machine and the object to be destroyed. He turned up at Boston last summer, formed a stock company, and got 1,800 dollars for a preliminary experiment. A little steamer was obtained, and in a dark house on its deck, with careful privacy, Wingate arranged a great amount of apparatus. On the day appointed for the test (a few weeks ago) an old vessel was towed to a safe point in the bay, and the steamer was stationed a mile away. Suddenly there was an explosion at a considerable distance from either craft, and afterwards the wreck of a rowboat, with two mangled human bodies, was found at the spot. Wingate, greatly agitated, said that his experiment could not be carried out that day. The newspapers could not at the time ascertain the facts. Now the *Boston Herald* gives an explanation, based on a confession by Wingate to one of the stockholders. The trick used at New Orleans, and to be repeated in Boston, was to explode a large dynamite torpedo under the vessel by means of a rope running to the pretended electric apparatus. The two men were on their way to place the torpedo when an accidental explosion occurred.—*Chicago Tribune.*

Electric Time-Ball for India.—The Indian Government having decided upon erecting an electric time-ball and gun-firing apparatus at Fort William, Calcutta, the same has been designed by Mr. S. Alfred Varley, who has had special experience in this class of electrical mechanism. The apparatus consists, in the first place, of a clock, which will be placed at the observatory, together with a commutator for sending electric currents to lock and to release the time-ball, and to actuate the gun-firing apparatus, and which also records at the observatory the correct operation of the same. In the next place there is the time-ball and its locking apparatus, which will be placed at Fort William, with the gun-firing mechanism in its vicinity, the two being connected by electric wires with the commutator and clock at the observatory, which may be any distance any way. The time-ball is 5ft. 6in. in diameter, and weighs, with its attachment, about 5cwt. It is wound up a mast by means of a rack and pinion, and when released falls through a space of 10ft. Attached to the ball, and beneath it, is a rod having a piston at its lower end. After the ball has fallen four feet this piston enters a pneumatic cylinder, in which it meets with resistance from the contained air. The air forms a cushion, and allows the ball to finish its descent without any shock or concussion being experienced, this result being assisted by a pressure relieving valve in connection with the pneumatic cylinder. The ball, as regards its size and the space through which it falls, is similar to those which were erected at Charing-cross and Liverpool in 1853 and 1854 at the suggestion of the Astronomer-Royal, to whom we are indebted for the idea of utilising electricity for discharging time-balls. Improvements in detail have, however, in the present instance been introduced by Mr. Varley, both in relieving the air pressure and in insuring greater rapidity and certainty of action by means of special mechanical and electrical arrangements. The apparatus for India has been manufactured at the works of Messrs. Siebe and Gorman, Mason-street, Westminster Bridge-road, where its working was lately inspected by General Hyde and Mr. W. F. Batho, C.E., on behalf of the Indian Government, and by whom it has been duly approved, and will be forthwith sent to Calcutta. We may add that a set of time-ball apparatus similar to that just described is in course of construction for another Indian station.—*Times.*

Public Speakers and Telegraphy.—We should be glad to give the compiler of the following statistics the credit due if we knew who carried out the compilation. Our authority is *The Colonies and India*:—"The following table, showing the nnmber of separate speeches made by each of the chief public speakers during the last seven years, the number of words reported, and the cost of reporting and telegraphing, is interesting. The table may be taken as complete, so far as it relates to the number of words and speeches :—

Name of Speaker.	No. of Speeches.	Words.	Cost of Rpg. and Tlg.	Name of Speaker.	No. of Speeches.	Words.	Cost of Rpg. and Tlg.
			£				£
Gladstone, W. E.	34	215,000	724	Hugessen, K. ...	7	15,200	44
Bright, John ...	24	129,300	571	Childers, H.C.E.	8	13,900	39
Beaconsfield, El.	24	90,300	468	Mundella, A. J..	8	14,100	39
Hartington, Ld..	25	113,700	383	Roebuck, J. A....	7	11,400	36
Northcote, Sir S.	26	100,909	811	Lawson, Sir W..	12	15,100	35
Forster, W. E....	32	91,100	297	Northbrook, Ld.	5	11,200	30
Cross, R. A. ...	21	70,525	211	Fawcett, Henry.	11	14,200	30
Salisbury, Lord.	14	50,100	147	Holker, Sir J. ...	5	11,600	24
Derby, Lord.....	17	47,700	137	Goschen G.	2	5,100	21
Cranbrook, Lord	8	25,200	101	Baxter, W. E....	6	8,500	17
Harcourt, Sir V.	16	43,900	100	Trevelyan, G. O.	8	9,900	17
Stansfeld, J. ...	17	28,800	99	Chamberlain, J.	5	9,100	16
Lowe, R.	5	24,200	97	Giffard, Sir H....	5	6,400	15
James, Sir H. ...	11	34,600	90	Lefevre, Shaw...	7	6,200	15
Granville, Lord.	10	28,900	74	Smith, W. H. ...	3	6,600	12
Beach, Sir M. H.	8	22,700	58	Sandon, Lord ...	3	3,100	8
Carnarvon, Lord	13	24,900	55	Dodson, J. G....	3	2,800	4
Stanley, Colonel	6	18,700	51				

It will be seen that Mr. Gladstone heads the list and distances all competitors in the number of speeches (34) and words (215,000). Mr Bright comes next with 24 speeches and 129,300 words. He is followed by Lord Hartington with 25 speeches and 113,700 words. Sir Stafford Northcote has made 26 speeches with 100,909 words. Mr. Forster 32 speeches, 91,100 words; and the Earl of Beaconsfield 24 speeches with 90,300 words. If we take the pecuniary test we find that for every 1,000 words spoken by the Earl of Beaconsfield 104s. have been paid for reporting and telegraphing; for Mr. Bright's speeches, 92s.; for Lord Cranbrook's and Mr. Lowe's, each 80s.; Lord Granville's, 78s.; Mr. Gladstone's and Lord Hartington's, each 67s. It must be remembered that the table only refers to separate speeches—that is, to occasions on which the person named was the sole or chief speaker. It does not include the many occasions on which the same speakers have appeared at conferences and other public meetings, when the honours were more divided. The most notable oratorical effort is the speech made by Mr. Disraeli at Manchester in April, 1872, when the number of words reported and telegraphed amounted to 16,700. No other speech compares with this in point of length. The next longest, amounting to 11,800 words, was Mr. Gladstone's speech at Oxford in January, 1878. The average length of the speeches can be obtained by dividing the number of words by the number of speeches made. This will give a correct idea of the speeches as delivered by two-thirds of the speakers. The remaining third, the last on the list, have not usually been reported verbatim."

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CORRESPONDENCE.

CARBONISED CARDBOARD.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: *The Times* Correspondent at Philadelphia has lately asserted that carbonised cardboard has recently been kept in a state of incandescence (giving abundant light) in vacuo, for many successive hours, without any perceptible destruction of the carbon itself. Of course if this is true, the question of electric lighting is solved, for carbonised cardboard is cheap, and if it is not destroyed in being rendered incandescent, it will not require renewal. It is, however, incredible that carbonised cardboard should be indestructible though other forms of carbon are burnt out* with more or less rapidity even in vacuo. *The Times* Correspondent clearly is not a scientific electrician, and I hope that some of your correspondents will tell us whether they believe that carbonised cardboard *can* be kept in a state of incandescence in vacuo without being consumed.—Yours, &c.,

January 6th. INQUIRER.

[* The carbon cannot become "burnt" in a vessel exhausted of air; but no doubt it would sooner or later become disintegrated by the effect of the heat.—ED. *E.*]

MAGNETIC APPLIANCES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am suffering under a painful ailment, and have been advised to have recourse to the much reputed power of electricity. But seeing that magnetic appliances are largely advertised as producing electric currents, I have some misgivings as to the truth of the latter, and knowing that you are an authority in such matters I venture to ask if you will kindly inform me if these advertised magnetic articles do really produce electric currents or any electric effect, and in what respect they differ from Pulvermacher's galvanic appliances.—Yours, &c.,

ARTHUR J. LEWIS.

102A, Mount-street, Grosvenor-square, W.,
January 1st, 1880.

[The "magnetic" appliances you refer to (unless they include some form of magneto-electric machine) produce no current or electric effect; although a conductor moving so as to cut the "lines of force" from any magnet is traversed by a current, the effect of which is to resist the motion. The galvanic appliances you also mention consist of small single-fluid voltaic couples, connected in series, and so constructed as to retain a portion of fluid by capillary attraction. Their electromotive force is sufficiently high to allow of the transmission of a considerable current through a high resistance, such as that of various portions of the human body.—ED. *E.*]

JUVENILE LECTURES AT THE SOCIETY OF ARTS.

The first of two lectures, by Mr. W. H. Preece, M.I.C.E., adapted to a juvenile audience, was delivered by that gentleman on the evening of the 2nd inst., at the Society of Arts, John-street, Adelphi. The theatre was densely crowded, the audience being composed for the main part of the sons and daughters of members of the society, who listened very attentively to the instructive remarks of the lecturer, and frequently testified their pleasure by warm applause or ringing laughter. The lecture was on "Recent Wonders of Sound," and, as promised, it was fully illustrated, explanatory diagrams being suspended against the wall of Reiss's, Bell's, and Edison's telephones, Edison's phonograph, Edmunds's phonoscope, and Crossley's telephonic transmitter, while frequent use of various objects was made by the lecturer to demonstrate his remarks in a practical manner. In the various experiments carried out he was assisted by Mr. Crossley, Mr. Stroh, Mr. Ladd, and Mr. Willmot. At the outset of his observations, Mr. Preece said he had nothing of a very novel character to bring before them, his object being, in fact, to impress on the mind of every boy and girl the fact that the advances in science had been chiefly attributable to experiments, which had brought new facts to light. Doubtless they had all at one time or other made simple experiments in connection with the phenomena of sound. It was, however, one thing to perform an experiment, but quite another thing to draw any practical inference or learn any lesson from it, and his object was to exercise their minds as well as their hands and eyes, and to show them not only facts but their cause. Sound was occasioned by the vibration of air, and air consisted of molecules, of which there were millions and millions in the room in which they were then assembled. He then showed how the molecules were set in motion, and sound produced, by crushing a bag which he had previously filled with wind, by blowing on a whistle, and by setting in motion the first of a row of marbles, the shock being transmitted to the last in the row, which bounded a few inches away from its fellows. Every time he threw these molecules into vibration by speaking or making any noise the sensation called sound was produced. Referring to the speed at which sound travelled, he reminded them that that was the reason why there were such things as echoes. Sound travelled at the rate of 1,100 feet per second in air, in water 5,000 feet per second, and 16,000 feet through wood. The motion of these molecules through the air was in itself very interesting. They were very complicated in their action the nearest approach to which was, he would say, the graceful waves made by the top or ears of barley when disturbed by the summer breezes. Drawing attention to a diagram of a human ear, he said they had seen how sound was produced and how transmitted, and it was received into the ear by the "drum" being affected by the motion of the molecules. Music possessed three distinct and separate qualities. First, the pitch of a note or the note itself was produced by the number of times the molecules struck the ear in a given period. This he illustrated by experiments on four tuning forks, the first of which was so constructed as to vibrate 256 times in each second. He then showed a disc with a number of holes pierced through it, and blowing through a tube nothing was heard, but on making his breath pass through the holes from the tube the disc was at once set in motion, and revolved at considerable speed, and sounds were produced as the air was broken up by the revolutions, the notes varying in accordance. He could almost make them see sounds, and in proof of this he made a series of experiments on Edmunds's phonoscope, by which the vibrations in the air caused by speaking, coughing, and laughing were made perfectly visible. The second quality of music was loudness, and that was produced by the increased velocity, or increased amplitude, given to the motion of these molecules. After referring to the action of speaking trumpets and foghorns in illustration of this part of his lecture, Mr. Preece spoke of the "quality" of music, and said this was simply due, not to the number of times or the blow with which the ear was struck, but to the form in which it was struck. The voice was one of the finest musical instruments, and differed in quality far more than any other apparatus for the production of sound. They never found two persons speak alike, and it was seldom that any one spoke in the same way twice. In illustration of the impress of sound, he spoke into a high hat, and, although they could not see the crown vibrate, he showed them that it did so by means of a telephone at the farther end of the room. Subsequently a small circle of light was thrown upon a screen by the phonoscope, and, the room having been previously darkened, the effects produced on it by various inflections of the voice were shown. Speaking of the transmission of sound, he referred to speaking tubes and telephones, and by means of a thin deal rod communicating through the floor with the basement, the sounds of music from a musical box were conveyed to the audience, a butler's tray being placed on the top of the rod for this purpose. When the tray was removed the sounds, of course, ceased. That, he explained, was the first telephone. Crossley's telephone was then called into requisition, by means of which messages were conveyed to and from the city, the replies from the latter place being distinctly heard, as were also whistling, singing, and playing on the clarionet. The lecturer explained that distance had nothing to do with the ability of the telephone, as Professor Bell and he had spoken through wire so thin that it was practically equivalent to speaking at a distance of 10,000 miles. Drawing attention in the next place to Edison's phonograph, or talking machine, he remarked that the human voice was reproduced by it with marvellous exactitude. Various sentences were then spoken into it, and reproduced with absolute correctness, the crowning experiment being when Sir Theophilus Shepstone, at the request of the lecturer, spoke into it in the Zulu language. The words, even the "clicks," for which there is no equivalent in the English language, were faithfully reproduced by the instrument. Mr. Preece then closed the lecture with a few kindly remarks to the juvenile members of his audience, who, judging from their applause, will long remember the interesting occasion.

TECHNICAL PHYSICS.*

I will commence this, the first of the regular lectures, with a few introductory remarks about the proper method of studying, for, while in learning, as in all other occupations, there are many wrong methods that may be followed, there is only a single correct one which will lead to success. The most difficult portion, perhaps, of a beginner's education is learning "how to learn," and from ignorance of this art many students not unfrequently spend much time and energy in puzzling through books and poring over problems without finding themselves at the end much the wiser for all their trouble. Consider how you acquire the manual skill required for your trade. Almost at the very outset you come to difficulties. The carpenter's apprentice, when he first tries to plane, botches the wood terribly, when he saws, the principal result attained is that the saw has to be re-set; to file even a small piece of metal true, how difficult it is for the beginner. Now, how did you get over this? Why, by perseverance, by trying over and over again, until at last you ended by being successful.

But in the Inaugural Lecture we spoke of the training of the mind leading to so much greater results than the mere training of the hands. We can hardly, then, expect that this mental training, or what is commonly called education, will be more easily obtained than the manual training. You will meet with difficulties, meet with them probably at the very beginning, but do not be discouraged by that; the student who finds the greatest number is often the very one who is learning most, he is digging deeper into the ground, and so is meeting with the harder earth. Swimming is easy enough as long as you stay on dry land; it is not until you have made your first plunge into the water that you begin to find it difficult, but it is not till then that your swimming education has really begun.

When you are reading a book, or when you are hearing a lecture, you come to something you do not understand, don't take what is told you for granted, do not slur it over and think, oh! the book or the lecturer says so, therefore, it must be right. If I open my hand this stick which I am holding, you know, will drop. How do you know it? Not because I tell you so, or

* A Course of Lectures on Some of the Practical Applications of Electricity and Magnetism. Delivered by Professor Ayrton to the City and Guilds of London Institute.

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because you have read it in some book, but because you have tried it yourself, you have seen things fall over and over again, you are absolutely certain the stick will fall, and if I told you that things left to themselves went up instead of down you would not take that statement on trust, you *could not* take it on trust even if you wished to. "Seeing is believing," you might answer; and if I stuck to my erroneous assertion you would conclude I was dreaming, or else incapable of judging of the affairs of every-day life. And in the same way you must learn to acquire all physical truths, they must become part of yourselves, every attempt that you have made to find an exception must have resulted in failure. All experience having shown a given conclusion to be a true one, then and only then should you accept it. And it is this training students acquire in the habit of experimentally testing for themselves the truth of an assertion that gives so much importance to the laboratory work, in which the pupils themselves and not merely the teacher perform the experiments; consequently, in order that a proper education in natural philosophy shall be acquired, it is essential that, although the absence of time and the necessarily large supply of apparatus may render it impossible for every student to do himself every experiment it is advisable that he should see performed, still every pupil should at least make some experiments himself. But you will never acquire this art of learning if you slur over difficulties under the hope that what the book or the lecturer says is all right. Such cramming may possibly enable you to pass an examination, and get a certificate; but there will be no training of the mind, no real education. If something you read or hear seems wrong, if you think it ought to be otherwise, then remember that either it *is* wrong, or it is *you* that are wrong, and do not rest satisfied until you have convinced yourself on which side the error lies. Learn to write your difficulty down in a concise form, attack it from every side, put it by, if necessary, until a subsequent day, if you are tired or busy with other occupations; but never forget there is that mental difficulty that has got to be settled, that has to be attacked and wrestled with. And when at length you do arrive at the explanation by your own efforts, or with the aid of your friends, or by asking me (for I shall always be glad, before or after every lecture, to answer questions) you will find that nothing can exceed the joy, the triumphant feeling of newly-acquired wealth that will reward you. One course of bricks in the building up of your mind, well laid, and the mortar firmly set, you are ready for another course, and so on, step by step, each layer tested in its turn to see that it and every layer underneath it is firm, you at length see the crowning roof put on a lofty building which no shaking can make a crack in.

Make notes of what you hear and see at the lectures, but catch the sense not the words of the discourse. A shorthand writer reports every word, often without even knowing what is the subject treated of, just as a telegraph clerk signals through a long message without catching one idea conveyed in the telegram, hence much of the secresy of the telegraph. And, lastly, every time that you add fresh notes, see that those last entered in your book are well understood and remembered.

When you ring an ordinary house bell, three important things are called into play—your hand, the bell wire, and the bell at the other end. If you are in a great hurry, you pull, perhaps, the handle vigorously; you exert much force, and the bell rings loudly; or if the person at the house you are calling at is ill, you pull the bell gently, so as to produce only a little noise. Now, when I press this handle, that bell on the other side of the room rings, but, unlike an ordinary bell, the sound, you see, is independent of the force I exert to press the handle. In fact, the two cases differ in exactly the same way as does shooting with a bow and arrow, and firing with a gun. With the bow and arrow the flight of the arrow depends on the strength I exert in drawing the bow, whereas with a gun the bullet flies just as far whether I pull the trigger very gently, or whether I pull it with all my might. The arrow is shot forth by my hand, or, at least, by the work done by my hand, stored up in the bent bow; but in the case of the gun it is the explosion of the gunpowder that impels the ball. The burning of the gunpowder gives the bullet its great speed, just as the burning of the coal in the furnace of a locomotive urges on the railway train, whereas when shooting with a bow it is the burning of the food inside my body that supplies the motive power. Similarly, when I pull an ordinary bell some food is burnt in my body to enable me to perform the pulling. Now, on an electric bell all my hand does is to pull a trigger to fire off, so to say, the galvanic battery.

A galvanic battery is a furnace of a particular kind. Fuel can be burnt in it, but the burning only takes place, or, at least, should only take place when an electric current is being produced outside. In ordinary steam engines there is no exact analogy to this, since the burning of the coal depends only on the stoker, and is independent of the work done by the engine; but in the locomotive engine, with the blast tube invented by Stephenson, we have something not unlike the burning in a galvanic battery, for the more steam that is used, the more goes up through the chimney, the greater the draught, and the quicker burns the fire. A galvanic battery, I say, is a furnace in which fuel is burnt. What fuel? Usually zinc; but you will say, Zinc! Zinc cannot burn. Well, I do not suppose one would use it to put on an ordinary fire, but it will burn, nevertheless. Iron is not the sort of thing you would select for burning, seeing that ordinary fireplaces are made of iron, because iron does not easily burn, and yet you all know that a piece of iron left in a damp place rusts away, becomes smaller and smaller. Now, what else is this rusting but a slow burning? And this slow burning can be made visibly rapid if only we supply the oxygen gas more rapidly than it is supplied by the ordinary air. This iron spoon contains small scraps of zinc. I put it into the gas flame and direct on to it a jet of oxygen, supplied by the gas compressed in this iron bottle, and you observe the burning of the zinc with a blue flame. Or, again, this glass jar is full of oxygen. I set light to a piece of phosphorus on the tip of one of these bits of zinc in this iron spoon, and plunge the whole into the glass jar through a hole in the top, and you observe the burning of the fragments of zinc. When zinc burns, a white substance called zinc oxide is formed, which you may perceive producing a white cloud. But there is another way of supplying oxygen rapidly to zinc besides sending a jet of the gas on to it, and that is by putting it in some chemical containing oxygen and willing to part with its oxygen. Dilute sulphuric acid is such a liquid. Sulphuric acid I have in this bottle, some of it I mix with water and drop into it some pieces of zinc, and you observe the rapid boiling accompanying the burning of the zinc. Now, this is the kind of burning that takes place in a galvanic battery, and the plate of zinc before you is one that has been nearly burnt up in a battery producing electric currents. This voltaic cell, as it is called, is the simplest form of such an electric furnace. A plate of zinc and a plate of copper are dipping into dilute sulphuric acid, near one another but not touching one another inside. Judging from the quietness of the liquid, we should say that the burning taking place inside the cell is either nought or very small. But if I connect the zinc and copper plates together outside by a wire, you observe that violent bubbling takes place, and if this wire passes, as it does now, several times round a magnet balanced on a pivot, the magnet which was before parallel to the coil of wire now places itself nearly at right angles to the plane of the coil. An electric current is then produced, and the zinc is burnt up. Directly, however, as you see, I make the smallest break in the wire the burning ceases, and with it the electric current and the deflection of the magnet. In actual practice we do not use so simple a form of galvanic cell, because the two gases (oxygen and hydrogen) which are produced by the decomposition of the water, or of the dilute sulphuric acid, settle on the zinc and copper plates and stop the action. I will explain to you on some subsequent occasion how this difficulty was overcome by Daniell. It is sufficient for our present purpose to understand that the zinc is burnt, an electric current is produced, and this electric current can do work outside the battery just as a steam engine can do work as an equivalent for the coal consumed in generating the steam. For example, if I connect the two wires coming from this battery to this electro-motor, you observe that it turns round rapidly and exerts considerable force—enough to drive, certainly, a small machine. Zinc is burnt up in this battery, and work is done outside.

One of the effects of an electric current passing along a wire is to cause a magnet placed parallel to the wire to try and put itself at right angles to it. Another is to make a piece of soft iron round which it is wrapped into a magnet. Through this coil of wire wrapped round this horseshoe-shaped iron bar I pass an electric current, and you see the two ends of the bar have acquired the power of holding up large masses of iron nails, which, of course, they had not before. Now, the moment I make a break in the wire, the electric current ceases, and the iron loses almost, but *not quite* instantaneously, all its magnetic properties, the nails falling to the ground. Another property of an electric current is to generate heat always in any wire through which it is passing. This fine piece of platinum wire is now cold, but on allowing the current to pass it becomes, as you see, white hot. Friction, you know, produces heat, and that is why we oil the bearings of the axles of wheels, why we put water on a grindstone and on a drill boring into metal. In very hot, dry countries, like India, they even wrap straw round the spokes of the wheels of the posting carriages, and at the end of every stage throw water on the straw to prevent the spokes becoming loose from the heat generated in the rapid travelling. In some countries they still have a "fire-drill" for producing a light by rapid turning, and even in England the flint and steel are not so very far in the past, not to mention the older forms of lucifer matches in which the light was produced simply by the heat caused by rapid friction.

Now, when a strong electric current is flowing through a fine wire, just as when a great crowd of people are crushing through a small doorway, there is much jostling and friction, the people become hot, so do the particles of the wire. Unless there is a panic, the worst that generally happens to the people is that they lose their tempers, but the particles of the wire become so hot that they shine.

We have spoken about the properties of an electric current, but what we really mean by this is that under certain conditions we find a wire possessing various properties simultaneously which it does not usually possess.

In such a case we say an electric current is flowing along the wire, but which way it flows, or whether anything flows at all, nobody knows. We even talk of the current flowing from the copper to the zinc pole of the battery outside it, but that is a mere convention to facilitate conversation, just as we talk of going "up to town" and "down into the country," even when the town is in a valley, and the country on the top of a hill.

It is the second property of an electric current, its power to convert a piece of iron into a magnet, that is utilised in an electric bell. Here is a piece of iron, an armature as it is called, supported on a hinge, and held away by a spring from the end of the magnet. If, however, by pressing together these two pieces of metal by means of this handle, I allow an electric current to pass through this coil of wire forming the electric bell, the armature is attracted and held against the magnet, a hammer attached to the end of the armature striking against the bell in its motion. To release this armature, I must separate these pieces of metal, or break contact, as it is called. Such an arrangement then constitutes what is called a "single stroke bell," and is much used for signalling the departure of trains on railways; one bell indicating, say, up train left, two bells down train left say, three bells, perhaps, indicating the passing of a luggage train. For domestic purposes such an arrangement would be somewhat inconvenient, as a servant might not hear one stroke, and to keep the bell ringing requires that one would have to go on making and breaking contact with the hand. This difficulty, however, can be overcome by what is called a "trembling bell," in which this making and breaking contact is done automatically. Instead of the electric current passing direct round the coils of the electro-magnet of the bell it has, in its course, to pass from this small spring to the armature. Now, what must happen when the electro-magnet attracts the armature? Why, that the armature leaves the little spring. The current is thus interrupted, and the big spring able to pull the armature back again. Every time the current passes the armature is attracted, the bell is struck, but the contact is broken, and the armature pulled back again, and thus a constant oscillation of the hammer and ringing of the bell is kept up as you now see it. The arrangement is not unlike the valve attached to the cylinder of the steam engine which shuts off the steam by the motion of the piston each time the piston is making a stroke. An electric bell is, in fact, one of the simplest forms of electro-moters or machines in which constant motion is produced by an electric current, for, by means of a crank and fly-wheel, this rectilinear motion of the hammer can, of course, be converted into continuous rotatory motion. A simple contact maker for ringing such bells is this button, the interior of which the drawing clearly explains.

This other instrument is a trembling bell and battery combined, in which, on turning this handle, a continuous ringing is kept up for summoning men to work, &c., without a man being required to continue pulling a rope, as is usually necessary in factories, schools, &c.

(TO BE CONTINUED.)

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THE EDISON LAMP.

The history of Mr. Edison in connection with the electric light is at once interesting and instructive. In the autumn of 1878 he paid a visit to Ansonia, where he saw Wallace's machine. On his return home he studied and experimented with electric lights, the result being that in October, 1878, his experiments were said to be crowned with success. Gas shares fell enormously, and the cool speculators netted their thousands. Since October, 1878, in a recurring period of about three months, the newspaper world startled us with the news that Edison had solved the problem of the electric light, and that his system was a proved success. There is no use in our attempting to hide the fact that we are getting tired of this sort of thing. The question of the electric light is to us a most important one. We are anxious to see the efforts of students successful, but we have never credited, and we will not allow ourselves to credit workers with successes they have not achieved. In a recent article on another question, the *Spectator* took the pessimist's view of the case, the result being totally different from what was anticipated. Our contemporary, however, gives excellent advice to owners of gas shares. They would do better to consult experts than to commence what might become in a few days a ruinous stampede.

With regard to Mr. Edison's work on electric lighting, we have every reason to believe he entered an entirely unknown path in 1878. Since then he has imbibed the rudiments of his electrical education in this direction, but as yet he has not given to the world one single idea, nor invented one single piece of apparatus that has carried us nearer to the general use of electricity as a source of light. So far as we know, there is not a single piece of electric light apparatus in the world in public use that comes from Mr. Edison. His 1878 experiments ended in failure, his motor was a failure, his platinum-iridium lamp was a failure, and we do not doubt but that his "cardboard" lamp will also prove a failure. Be that as it may, we think we can prove that neither cardboard, nor platinum, nor any other of his published plans is original. The British Patent Office contains many secrets, and we shall be surprised if the embryo cardboard lamp is not amongst them. We are told that Mr. Edison was led to experiment in this direction by certain results obtained from carbonised cotton. Mr. C. W. Harrison may be able to state whether more than twelve months ago the carbonised cotton did not form the principal basis of his system of flexible carbons. Exhausted globes are not new, and, what is more, not quite so cheap as the newspapers would have us imagine.

There is this peculiarity in all that emanates from Menlo Park: figures are given to prove the truth of the statements. The last new lamp is to cost a shilling. Now, this lamp consists, in the first place, of a globe exhausted by means of a Sprengel pump to one-millionth of an atmosphere. It contains the carbon in good contact with platinum wire, and is necessarily furnished with binding screws. The wood of the lamp has to be turned, the globe exhausted, made air tight by means of cement or otherwise, all of which costs money, to which must be added the first cost of wood, globe, cement, platinum, copper, &c., the labour of preparing the carbon, and putting together the apparatus, and yet the whole is to be obtained for a shilling. Our experience is that the binding screws and the platinum will cost all the money. The method by which Mr. Edison makes his contact is certainly ingenious; it is however a modification of a test-tube clip, well known in every chemical laboratory. But there is no doubt that the cohesion of the carbonised paper must be very weak, and that the "wick" would require very careful handling before being safely ensconced in the exhaused receiver. However, admitting that the apparatus may in skilled hands be easily constructed, we have to inquire how long the carbon will last. According to all previous experiments, and these have been extremely numerous, carbon, whether in a vacuum or not, slowly but surely disintegrates, and sooner or later the lamp becomes useless. It seems to us that Mr. Edison's carbon, being less dense than retort carbon, will probably disintegrate in a shorter time. In the use of such lamps great difficulties would arise. Whenever such an accident happened to a carbon, the householder could hardly be expected to break the seal of the globe, insert the new carbon, and again obtain the vacuum. In fact, a new lamp would have to be kept ready to replace the old one, and the latter would have to be

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sent to the factory. Now, if there is one thing which the householder dislikes it is to get into difficulties with his light. Gas plays pranks at times and nearly drives him mad, his oil lamp gives a bad light, and he anathematises the wick or the oil ; but when it comes to the trouble of obtaining a vacuum, the insertion of a new "wick," or the expense of a new lamp, he will probably feel inclined to return to his old love.

Altogether it will be seen that the new lamp, when carefully considered, promises to be neither so simple nor so cheap as its advocates would have us believe, and, therefore, it would be well for holders of gas shares to take heart and not to be in a hurry to realise.

We must credit Mr. Edison with energy and ingenuity, but, as yet, we fail to see that he has solved the problem of the electric light. His devices have gradually approached nearer and nearer to the best of his competitors, till it may be said he stands on the confines of discovery. His next departure, if it shows similar progress to previous ones, will probably go a step towards solving the great question. Whilst, then, gas need not fear immediate innovation from what has been done, it must recognise that the electric light is a fact, and submit with a good grace to its advances. As we have often stated, gas will find new fields of usefulness, even should it be supplanted in certain places as an illuminant by electricity. Our objection to the manner in which Mr. Edison's work is made public, is, we feel, a strong one. More than once have gas stocks suffered from statements made in telegrams to the daily press, which have ultimately been found to lead to nothing. We warn Mr. Edison that if he values his scientific reputation, if he desires to rank as something more than one who is so careless as to allow his work to be made a tool in the hands of speculators, he must take more precautions when allowing his work to be made public. Any one who reads the history of electric lighting during the last fifteen months will be struck with the rash statements that have been attributed to him. It is essential that the work should be subjected to the most exhaustive proofs before being put forward as successful.

ON THE CAPILLARY ELECTROSCOPE.*

BY G. GORE, LL.D., F.R.S.

The following research was commenced with the hope of being able to make an exact measuring instrument of a modified form which I had devised (see page) of the "Capillary Electroscope," and to employ it for the determination of the different degrees of electromotive force of different metals in forming tables of electro-chemical series, with different electrolytic solutions.† With this object in view, I constructed and tried a considerable number of forms of the instrument, and employed a number of liquids, acid, neutral, and alkaline, as conducting media between the mercurial electrodes. In every case, however, an obstacle to uniform and accurate measurement sooner or later arose, viz., unequal adhesion of the mercury to different parts of the capillary tube.

It has been noticed by other investigators that the motion of the slender column of mercury in Lippmann's "Capillary Electrometer" suddenly stops whilst under the electric influence, and this has been supposed to increase the value of the instrument by rendering its indications sensibly instantaneous. According to Lippmann also "when the circuit was closed" by a metallic conductor, "all irregularities at once disappeared" (*Phil. Mag.*, April, 1874, p. 284). This sudden stoppage of the mercury, however, whilst under the influence of the current is, I believe, in every case due to a sudden increase of mechanical resistance, usually caused by unequal adhesion of the mercury to different parts of the tube, but sometimes by a minute trace of solid substance in the tube. With a very feeble current this adhesion shows itself in several ways, usually by a more or less sudden retardation or stoppage of the motion of the mercurial column, by a delay in its commencement of motion, or by its non-movement. The current I have employed has, in nearly all cases, been a very feeble one, obtained from two wires, one of copper, and the other of platinum, each about 1 millim. diameter, immersed about 2 or 3 millims. deep in common drinking water. With a very sensitive instrument, and a capillary tube as free from obstruction as could be obtained, this power has been sufficient to move the meniscus 10 or 20 millims.

A common cause of obstruction consists of impurities (especially oxide) in the mercury ; the metal therefore should be as pure as possible. I have obtained it sufficiently pure by distilling the ordinary metal twice, when shaking it violently with dilute nitric acid, washing it with distilled water, shaking it again strongly with a dilute solution of potassic cyanide (which very effectually removes oxide), washing it again, and filtering it through a minute hole in the point of a paper funnel. The mercury should be kept in a closed bottle, and be frequently filtered to remove dust from its surface whilst being used, because the most minute speck of solid matter, even that which is invisible to the unassisted eye, is sufficient to stop the capillary tube. The solution also should be kept perfectly clear by means of filtration. Another cause of stoppage is the employment of glass tubing into which dust has been allowed to enter ; this may be obviated by employing newly-made tubing, sealed at its ends by wax ; with such tubing I have obtained no manifest advantage by washing it with acids, alkalies, ether, &c., nor by allowing a stream of clean mercury to run through it. After having taken all these precautions, there remains a very common cause of stoppage of the motion of the mercury, viz., portions of air or gas adhering to the tube ; these consist either of minute films of air, or if the current is too strong, also bubbles of gas liberated from the electrolyte.

One of the most effectual modes of removing the air or gas is to repeatedly cause by mechanical means (such as compression of the pressure-chamber, or by change of position of the instrument from horizontal to vertical, and *vice versâ*) the mercury and conducting solution to move freely to and fro through the whole of the fine part of the tube whilst the circit is closed, and expelling occasionally a few drops of mercury from the end of the tube, employing also an electric current in a suitable direction to assist the motion. If there remain any adhering portions which are not removable by these means, diminished pressure, combined with an electric current from the point of the capillary towards its larger part, and the simultaneous application of a hot plate of metal to the locality of the adhesion rarely fails to remove them. Notwithstanding, however, all these precautions, the meniscus often subsequently sticks at a particular place without any apparent cause, and without the presence of any body visible by the aid of a microscope magnifying from 30 to 50 diameters. Free use of the instrument reduces many of these adhesions ; it also gives rise to fresh ones. Immovable adhesions of the mercury frequently occur, or are subsequently produced by use of the instrument, which interfere with the accurate measurement of so feeble an electric power as that mentioned above, and appear to be due to irregularities of smoothness in the glass itself. The best precaution to take in such cases consists in selecting as the sphere of the movement of the meniscus a portion of the capillary tube known to be free from such a source of error ; but even such a space does not permanently remain free.

By employing a suitable tube, dilute sulphuric acid as the liquid, and taking all the above precautions, I have constantly found that the mercurial column, instead of moving from point to point with a jerk and stopping suddenly, moved with a gradually diminishing speed until it stopped. The momentary movement and sudden stoppage occurs more readily with a short capillary tube and currents of greater power than that above mentioned, but with a long tube, as free as obtainable from irregular adhesion, a movement of from 10 to 20 millims. not unfrequently occurs, requiring in some cases as much as 80 millims. variation of height of mercury pressure to bring the meniscus back to its original point. If the tube happens to be one of parallel bore, and especially if its lower part enlarges towards its lower extremity, such a current as the one mentioned will cause the meniscus to descend as much even as 5 or 6 centims., and the mercury to run out at the end of the tube. The influence of gravity no doubt operates in all these cases, but with the same electric power, and whilst using a tube the diameter of which does not diminish too rapidly towards its point, the column usually moves more readily towards the end of the capillary than the reverse, whether the instrument be in a vertical or horizontal position. The mercury in all cases tends also to pass from the

* Abstract of a paper presented to the Royal Society.

† See "On the Chemico-Electric Relations of Metals in Solutions of Salts of Potassium."

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form of a cylinder to that of a sphere, and if it once gets beyond the end of the tube, it forms a globule which draws the narrower part rapidly into itself by its great cohesion. Similarly if the tube is too taper the mercury tends to draw itself upwards towards the wider cavity.

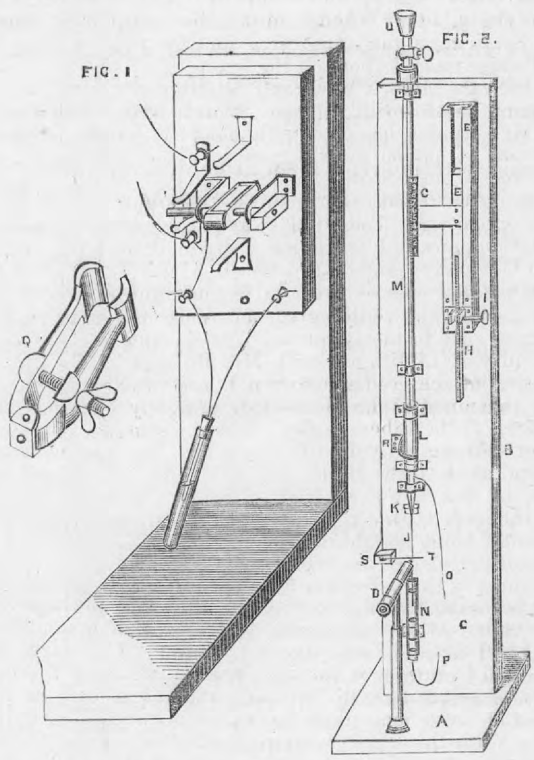
A good capillary tube is essential; the only way I know of obtaining it is to make a number of tubes and try them until a suitable one is found. Glass tubing, of an external diameter of about 6 to 8 millims., and having a bore of about one-third or one-fourth of a millimetre, is of a very convenient size for making the capillary, because it may be drawn out to a sufficient degree of fineness at one heating; that having a circular bore it is less likely to become clogged by use than that which is oval; and it is an advantage to employ that which has white enamel at the back. Success in making the capillary depends largely upon careful manipulation and the employment of a flame of suitable size; I have used a Bunsen flame about an inch in height and half an inch in diameter for drawing long capillaries by a single heating, or a very minute flame of a small spirit-lamp for drawing out a short one by a second heating. Within certain limits, I have found that the finer the capillary tube the greater is the movement in it of the meniscus by a given electromotive force, and the greater the pressure required to balance that force; but if the bore of the tube be extremely fine, say ·01 millim., the instrument becomes less sensitive, probably owing to increased adhesion or to increased conduction-resistance of the minute column of solution. A convenient bore is about ·03 to ·04 millim., and an external diameter of ·3 to ·4 millim. Under uniform pressure, the meniscus moves not only through a much greater length, but also at a much faster rate, in the finer portion of a tube of moderate diameter, than it does in the coarser part, and this occurs even in tubes the internal diameter of which diminishes to their very extremity. Tubes of parallel bore are not usually suitable for the instrument (especially if the latter is used in a vertical position), because, instead of presenting a resistance gradually increasing downwards, as they should do, they offer the reverse. The best form of capillary is one which becomes narrower at a sufficiently increasing degree towards its free end. I have employed capillaries varying in length from 5 to 15 centims. with equal advantage.

Considerable pressure is often requisite for filling the capillary tube, and for overcoming obstructions; to produce it, a compressible pressure-chamber is much more convenient than a tall column of mercury. An excellent chamber may be formed of a piece of vulcanised india rubber tubing, about 6 or 8 centims. long, 3 millims. bore, and 15 millims. external diameter, such as is employed as "engine-packing." It is more convenient to have the platinum wire (for connection with the column of mercury) inserted through the side of this tube than through that of the glass one, because the former does not so readily cause the wire to be broken. To insert the wire, one end of the tube is stretched open by means of a small pair of pliers; a needle, wet with glycerine, is then forced very obliquely through the india rubber close to the end of the tube, and after its removal a fine wire may be readily forced through the minute stretched hole and the pliers then withdrawn. After the capillary tube has been fixed in this chamber (which must be previously made scrupulously clean), the end of the chamber adjacent to the terminal and capillary must be securely bound round with wire to prevent leakage. As it often requires considerable pressure to force the mercury through the tube, especially when there exists both a mechanical obstacle and a stoppage of the electric current, a strong pressure screw, with its clamp capable of grasping at least an inch in length of the chamber, is absolutely necessary.

I have tried several plans of mechanically compensating the electro-capillary effect, the most convenient of which is to surmount the pressure-chamber by a vertical glass tube about 30 or 40 centims. high, and 1 millim. bore, with its lower end opening into the chamber, and its upper end also open, but capable of being closed by means of a glass cock, having an open cup at its upper extremity. This arrangement admits of great pressure being applied to the chamber, by means of the screw and clamp, and also of crudely measuring in millimetre height of mercury the compensating pressure necessary to depress the mercury to the neutral point whilst the current is passing. This upper tube also, like the capillary one, has the disadvantage of offering unequal resistance to the passage of the mercury by unequal adhesion, so that a small movement of the screw of the pressure-chamber is not often at once attended by a simultaneous movement of the mercury at the top and bottom of the column.

The voltaic current was very conveniently manipulated by the aid of a small movable apparatus, so constructed that by turning its handle the first quarter of a revolution, the two wires of the electroscope were connected metallically together, and the current insulated from them; by turning it to a second quarter, the current was sent in one direction through the electroscope; by turning it a third, the wires of the electroscope were disconnected and perfectly insulated (the base of the instrument being of ebonite); and by turning it the fourth quarter, the current was sent through the electroscope in a reverse direction. This apparatus may be easily made by prolonging the axis of a common electric reverser, fixing two projecting metal studs on opposite sides of the prolonged part (*but not opposite to each other*), and attaching two vertical springs to two binding-screws fixed on the base, so that when the studs pressed against the upper ends of these springs, the circuit was closed between the ends of the wires attached to the two electrodes.

The following sketch, No. 1, represents the reverser fixed vertically to a movable wooden stand. The dotted lines show the directions of four connecting wires at the back of the ebonite base of the instrument. The wires from the voltaic cell are attached to two binding-screws, which are connected with the two metal standards that support the movable axis. The terminal wires of the electroscope are attached by means of binding screws to two vertical brass springs, so fixed as to press against the two metal studs projecting at right angles from the movable axis; the terminals are also further connected, by means of the wires beneath the base, with the two other and ordinary vertical springs of the instrument, so that by turning the handle they may be disconnected from the studs and connected with those springs, and through them, the axis and standards, with the voltaic cell, and receive a current in either direction, according to the position of the handle. The sketch represents the handle and axis in the above-mentioned first position, with the two wires of the electroscope metallically connected together, but insulated from the cell.



The usual form of the electroscope I have employed is represented in the annexed sketch No. 2. A is a wooden base, B a wooden upright board fixed to it. C is the situation of the reverser. D a microscope, capable of vertical and horizontal movement, having a magnifying power of about 30 to 50 diameters, and provided with a "spider-line." E is a grooved piece of wood fixed to the upright stand. F a wooden slide, with a movable scale, G, worked by a metal rack H, and pinion with handle, I. J is the capillary, supported by a perforated little brass shelf, K. L is the pressure-chamber. M the glass tube containing the compensating column of mercury. N a thin glass tube, about 5 millims. bore, containing the mercury and conducting solution. O and P are the terminal platinum wires for attachment to the screws of the reverser. Q is a strong clip, shown separate from the instrument. R is a metal support for the clip. S is a movable slide of cork, carrying a very fine hair, T, for indicating the position of the meniscus. It is not usually necessary to measure the amount of movement of the meniscus. Some cotton wool is placed in the cup, V, and the cup is covered with a lid to exclude dust. A strip of white paper is affixed

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behind the capillary portion of the tube to form a white background, and the instrument requires to be used in a good light.

Having found by additional experiments that in certain cases the mercury moves in an opposite direction to the electric current, I am now engaged in examining that circumstance, and in completing an investigation of the causes and conditions of the movements.

CELEBRITIES AT HOME.

MR. JOHN PENDER, M.P., AT FOOT'S CRAY PLACE.

After describing the residence of Mr. J. Pender, M.P., at Foot's Cray, and his early mercantile experiences, the *World*, in this week's issue, goes on to say:—

Mr. Pender had worked hard enough to be idle, and had amassed sufficient money to enjoy *idlesse*. But he found recreation only in change of occupation; and it may be said that the more important portion of his life commenced when he retired from business. He had early been connected with submarine telegraphy, being one of the twenty-eight Manchester subscribers of £1,000 who cheered Mr. Cyrus Field in his first attempt to lay the Atlantic Cable. This was in 1856, and, as every one knows, the attempt proved a disastrous failure. Mr. Pender's thousand pounds, in company with many others forming part of the £350,000 subscribed, lies at the bottom of the sea. Nine years later, the indomitable Mr. Field, coming again to London on his now familiar errand, found in Mr. Pender a man ready to provide one-tenth of the sum of £600,000 required for a renewal of the enterprise; Mr. Pender did more to make the work practicable. He was chiefly instrumental in bringing about a consolidation of the Gutta Percha Company, and the firm of Glass, Elliott, and Company, who in those days made all the sea cables. When a hitch arose, the Gutta Percha Company requiring a guarantee of a quarter of a million sterling, Mr. Pender gave it them on the strength of his own purse, and thus the now famous Telegraph Maintenance and Construction Company was formed, and the Atlantic Cable was laid. Since then Mr. Pender has had both hands in every scheme of the extension of submarine telegraphy. To-day he is chairman of the Direct United States Cable Company; of the Eastern Extension, Australasia, and China Telegraph Company; of the Globe Trust and Telegraph Company; of the Eastern Telegraph Company; of the London, River Plate, and Brazil Telegraph Company; and of the South Africa Telegraph Company, which has just opened direct cable communication with the Cape.

Mr. Pender has represented the Wick boroughs in two Parliaments. He formerly sat for Totnes; and in 1868 he fought the county of Linlithgow with Mr. McLagan. He did not win the seat, but achieved a victory not less valuable to the Liberal cause, inasmuch as he succeeded in finally bringing over Mr. McLagan to the Liberal side. It seems strange, in view of Mr. Pender's strong individuality and active life, that he should have made no mark in the House of Commons. If we are not mistaken, he has not even made a speech there. But he wields more influence than some who make many speeches, his advice frequently being sought in matters where special information and practical knowledge are worth more than words. He has spent large sums in the patronage of art; and his house at Arlington-street is famous among the private collections of English gentlemen. Some of his colleagues in the great public work of the Atlantic Telegraph were made baronets, as a mark of public appreciation of their Sovereign's favour. The member for Wick, who commenced with the Atlantic Cable, and has probably not concluded with the Cable to the Cape, remains plain John Pender. But he has the distinction of enjoying in a peculiar degree the intimate personal friendship of the leaders of politics, literature, science, and art; and whether at home at Arlington-street or Foot's Cray, there are daily gathered round his table men whose names are known wherever the English language is spoken.

EDISON'S LIGHT.

HISTORY OF ELECTRIC LIGHTING.

[From *New York Herald.*]

The near approach of the first public exhibition of Edison's long-looked for electric light, announced to take place on New Year's Eve at Menlo Park, on which occasion that place will be illuminated with the new light, has revived public interest in the great inventor's work, and throughout the civilised world scientists and people generally are anxiously awaiting the result. From the beginning of his experiments in electric lighting to the present time, Mr. Edison has kept his laboratory guardedly closed, and no authoritative account (except that published in the *Herald* some month ago relating to his first patent) of any of the important steps of his progress has been made public—a course of procedure the inventor found absolutely necessary for his own protection. The *Herald* is now, however, enabled to present to its readers a full and accurate account of his work from its inception to its completion.

Edison's electric light, incredible as it may appear, is produced from a little piece of paper—a tiny strip of paper that a breath would blow away. Through this little strip of paper is passed an electric current, and the result is a bright, beautiful light, like the mellow sunset of an Italian autumn.

"But paper instantly burns, even under the trifling heat of a tallow candle!" exclaims the sceptic, "and how, then, can it withstand the fierce heat of an electric current?" Very true, but Edison makes the little piece of paper more infusible than platinum, more durable than granite. And this involves no complicated process. The paper is merely baked in an oven until all its elements have passed away except its carbon framework. The latter is then placed in a glass globe connected with the wires leading to the electricity producing machine, and the air exhausted from the globe. Then the apparatus is ready to give out a light that produces no deleterious gases, no smoke, no offensive odours—a light without flame, without danger, requiring no matches to ignite, giving out but little heat, vitiating no air, and free from all flickering; a light that is a little globe of sunshine, a veritable Aladdin's lamp. And this light, the inventor claims, can be produced cheaper than that from the cheapest oil. Were it not for the phonograph, the quadruplex telegraph, the telephone, and the various other remarkable productions of the great inventor, the world might well hesitate to accept his assurance that such a beneficent result had been obtained, but, as it is, his past achievements in science are sufficient guarantee that his claims are not without foundation, even though for months past the press of Europe and America has teemed with dissertations and expositions from learned scientists ridiculing Edison, and showing that it was impossible for him to achieve that which he has undertaken.

When Edison began his experiments in September, 1878, he had just returned from the inspiring scenery of the Rocky Mountains, where he had been enjoying a little recreation after several months of hard labour. He was ripe for fields and enterprises new. A visit to a Connecticut factory where an electric light was used concentrated his thoughts on the subject of lighting by electricity, and he determined to attack the problem. Previous to this time, although he had roamed broadcast over the domain of electricity, wresting from it, as is well known, many of its hidden secrets, Edison had scarcely thought of the subtle fluid in connection with practical illumination. Now, however, he bent all his energies on the subject, and was soon deep in the bewildering intricacies of subdivision, magneto currents, resistance laws, and the various other branches going to make up a system of lighting by electricity. The task before the young inventor was divisible into two parts.

1st. The producing of a pure, steady, and reliable light from electricity; and

2nd. Producing it so cheaply that it could compete with gas for general illumination.

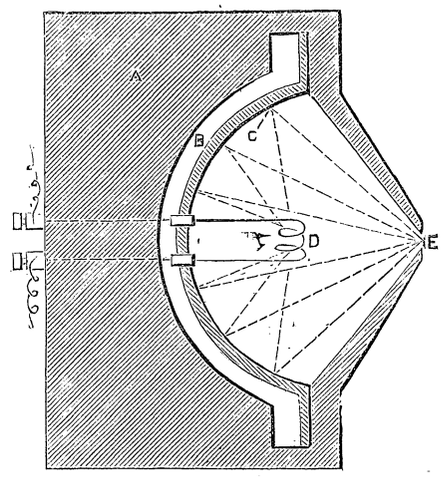

FIG. 1

Of the two systems before him—viz., voltaic arc and the incandescence system, Edison chose the latter as his field of operations. Prominent among the difficulties incident to incandescent lighting, it will be remembered, was the liability of the platinum (when that metal was used) to melt under the intense heat of the electric current, and the liability of the carbon, when that was employed, to gradually become dissipated under the combined action of gases and the electric current.

As between platinum and carbon as the substance to be made incandescent, Edison took up platinum and devoted first his attention to the obtaining of some device to prevent the platinum from melting under the intense heat of the electric current. An ingenious and simple contrivance met the requirement. He arranged a small lever, about three inches long, so that the expansion of the platinum (caused by the heat) beyond a certain degree would close it, such closing making a new passage for the electric current and cutting it off from the incandescent platinum. When the latter contracted, as it did the moment the heat was lessened, the lever returned to its normal position and allowed the electric current to again pass through the platinum. By this device the inventor hoped to be able to keep the incandescent platinum always below its melting point. [The contrivance has been described in *The Electrician.*]

The inventor next followed with a new regulator and a meter for measuring the amount of electricity used; also an automatic switch connecting the regulator with the line leading to the machine for generating the electric current.

The next was a unique idea, making the platinum give the light as it were by proxy. By means of a reflector he concentrated the heat rays of the platinum upon a piece of zircon, causing the latter to become luminous. Figure 1 shows the apparatus.

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A is a mass of non-conducting material, *b* is an air space, *c* is a polished reflector of copper coated with gold, *d* is a platinum-iridium spiral, which becomes heated by the passage of the electric current through it, E is a thin piece of zircon that receives the heat rays thrown off by the reflector C, which heat rays bring up the zircon E to vivid incandescence, making it give out a light much more brilliant than the light of the platinum spiral C. With this form Mr. Edison tried numerous experiments, and from time to time made many alterations and improvements, but eventually the apparatus was placed in the category of non-successes. Realising from the first the necessity of the light-giving substance offering much resistance to the passage of the electric current—a necessity in extensive subdivision of the light—the inventor throughout his experiments kept a close watch for substances and forms that gave suitable resistances. In Fig. 2 is shown a form of lamp disconnected from the regulating apparatus, which largely embodied the above requirement and for a time gave good results.

FIG. 2

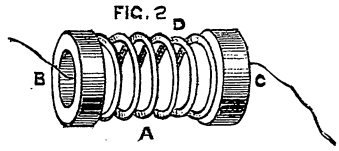
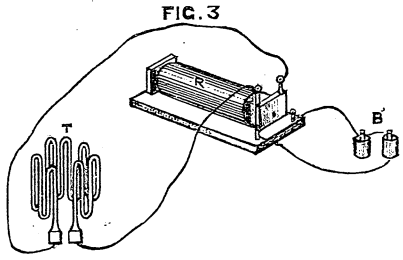


FIG. 3



A is a spiral of carbon with two large ends, B *e*, connecting with the wires leading to the machine for generating the current. This device was tried for several weeks, but did not, as a whole, give satisfaction. Branching off from the line of investigation he had been previously following, Mr. Edison at this time began experimenting with a view to having the light produced locally—*i. e.*, arranging for each householder to become his own manufacturer of light, thus dispensing with mains and central stations. The apparatus which he used for this purpose is shown in Fig. 3. R is an induction coil, such as are used by peripatetic showmen at fairs and other places when they give electric shocks to inquiring sightseers at so much per shock. It is operated by two cells of battery B, and wires lead from it to the glass tubing T, from which the air has previously been extracted, and the passage of the electric current through the tubing gives out a light. This plan is analogous to what is known as the Geisler tube arrangement, the difference being in the form of the tube, and the extreme smallness of the bore, and also in the degree of vacuum produced. Mr. Edison succeeded by this arrangement in obtaining a light of several candle-power with a moderately powerful induction coil. The light, however, was not the one sought after so persistently by the inventor, and so it took its place in that part of his laboratory occupied by inventions not in use. Once more Mr. Edison made a departure. He moulded powdered metallic oxides in the form of sticks, and subjected them to a very high temperature. In this connection he obtained very fine results from the native alloy of osmium-iridium, called iridosmine, which alloy he used in the form of a powder enclosed in a tube of zircon. The electric current passing through the same brought it to a beautiful incandescence. The inventor's next important move was the adoption of carbon in connection with platinum as the substances to be made incandescent. He caused a slender rod of carbon to rest upon another of platinum, the inferiority of contact between the two at their point of meeting producing a resistance to the passage of the electric current and causing the carbon to become highly incandescent, while the platinum attained only a dull red heat. The carbon rod was kept pressing upon the platinum by a weight ingeniously arranged. A dozen or more forms of this lamp were made; but, after all, the inventor was obliged to return to platinum as the substance most suitable, all things considered, for being made incandescent. For two months he worked at platinum day and night, only to find that platinum, as he had been using it, was entirely worthless for incandescent lighting. To many experimenters this would have proved a discouragement perhaps fatal, but it had the effect only of increasing Edison's determination. After scores of new experiments he arrived at the true causes of the defects and hastened to apply the remedy. "I have found," he writes, "that when wires or sheets of platinum, iridum or other metallic conductors of electricity that fuse at a high temperature are exposed to a high temperature near their melting point in air for several hours by passing a current of electricity through them and then are allowed to cool, the metal is found to be ruptured, and under the microscope there are revealed myriads of cracks in various directions, many of which reach nearly to the centre of the wire. I have also discovered that, contrary to the received notion, platinum or platinum and iridium alloy loses weight when exposed to the heat of a candle; that even heated air causes it to lose weight; that the loss is so great a hydrogen flame is tinged green. After a time the metal falls to pieces; hence wire or sheets of platinum or platinum and iridium alloy as now known in commerce are useless for giving light by incandescence—

"1st. Because the loss of weight makes it expensive and unreliable, and causes the burner to be rapidly destroyed.

"2nd. Because its electrical resistance changes by loss in weight, and its light-giving power for the total surface is greatly reduced by the cracks or ruptures.

"The melting point also is determined by the weakest spot of the metal. By my invention or discovery I am able to prevent the deterioration of the platinum or its alloys by cutting off or intercepting the atmospheric action. A spiral wire, or other forms of platinum, is placed in a glass tube or bulb, with the wire near its ends passing through and sealed in the glass, and the air is exhausted from the glass. The platinum wires of the spiral are then connected to a magneto-electric machine or battery, the current of which can be controlled by the addition of resistance. Sufficient current is allowed to pass through the wire to bring it to about 150 degrees Fahrenheit. It is then allowed to remain at this temperature for ten or fifteen minutes. While thus heated both the air and gases confined in the metal are expelled by the heat or withdrawn by the vacuum action.

"While this air or the gases are passing out of the metal the mercury pump is kept continually working.

"After the expiration of about fifteen minutes the current passing through the metal is augmented so that its temperature will be about 300deg. Fahrenheit, and it is allowed to remain at this temperature for another ten or fifteen minutes.

"The mercury pump is to be worked continuously and the temperature of the spiral raised at intervals of ten or fifteen minutes until it attains vivid incandescence and the glass is contracted where it has passed to the pump and melted together.

"The wire is now in a perfect vacuum and in a state heretofore unknown, for it may have its temperature raised to a most dazzling incandescence, emitting a light of twenty-five standard candles, whereas before treatment the same radiating surface gave a light of only about three standard candles. The wires after being thus free from gases are found to have a polish exceeding that of silver and obtainable by no other means. No cracks can be seen even after the spiral has been raised suddenly to incandescence many times by the current, and the most delicate balance fails to show any loss of weight in the wire even after it is burning for many hours continuously. I have further discovered that if an alloy of platinum and iridium is coated with the oxide of magnesia and subjected to the vacuum process described, a combination takes place between the metal and the oxide, giving the former remarkable properties. With a spiral having a radiating surface of 3-16 of an inch light equal to that given by forty standard candles may be obtained, whereas the same spiral, not coated by my process, would melt before giving a light of four candles. The effect of the oxide of magnesia is to harden the wire to a surprising extent and render it more refractory. A spiral made of this wire is elastic and springy when at high incandescence. I have found that chemically pure iron and nickel drawn in wires and subjected to the vacuum process may be made to give a light equalling that of platinum in the open air. Carbon sticks also may be freed from air in this manner, and be brought to a temperature where the carbon becomes pasty, and on cooling it is homogeneous and hard."

About this time another truth dawned upon the inventor, namely, that economy in the production of light from incandescence demanded that the incandescent substance should offer a very great resistance to the passage of the electric current. Concerning this the inventor writes:—"It is essential to reverse the present practice of having lamps of but one or two ohms (electrical units) resistance, and construct lamps which when giving their proper light shall have at least two hundred ohms resistance."

The lamp as it stood at this stage of the inventor's progress is shown in Fig. 4.

FIG. 4

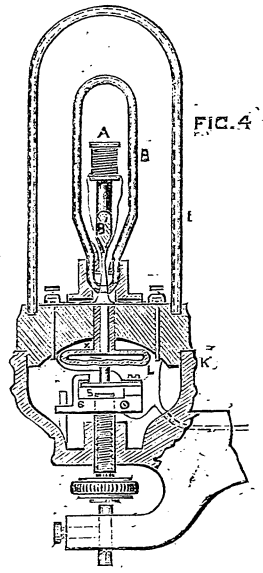
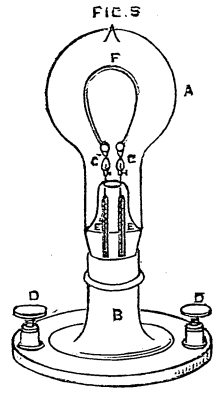


FIG. 5



a is the burner or incandescent platinum in the shape of a bobbin supported within the vacuum tube, *b*, by a rod, *b'*, of the same material as the bobbin. The vacuum tube, *b*, is sustained by the case, *k*, and around said tube, *b*, is a glass globe, *l*. Within the case, *k*, is a flexible metallic aneroid chamber, L, that opens into the glass case, *l*, so that the air, when expanded by heat, can pass into the aneroid chamber and give motion to the flexible diaphragm, *x*, and parts connected therewith. When the current circulating around the bobbin, *a*, becomes too intense and heats the latter too highly the air within the glass case, *l*, is expanded and bulges downward by the diaphragm, *x*, and the pin thereon pressing upon the spring, 5, and separating said spring from the block, 6, breaks the circuit to the burner. The temperature within the globe, *l*, lowers immediately and the parts return to their normal position, closing the circuit through the burner to 5 and 6. This opening and closing of the circuit is but momentary, and, therefore, the uniform brilliancy of the light is not affected, and there is no danger of the burner becoming too highly heated.

The lamp, after these latter improvements, was in quite a satisfactory condition, and the inventor contemplated with much gratification the near conclusion of his labours. One by one he had overcome the many difficulties that lay in his path. He had brought up platinum as a substance for illumination from a state of comparative worthlessness to one well nigh perfection. He had succeeded, by a curious combination and improvement

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in air pumps, in obtaining a vacuum of nearly one-millionth of an atmosphere, and he had perfected a generator or electricity producing machine (for all the time he had been working at lamps he was also experimenting in magneto-electric machines) that gave out some 90 per cent. in electricity of the energy it received from the driving engine. In a word, all the serious obstacles toward the success of incandescent electric lighting, he believed, had melted away, and there remained but a comparatively few minor details to be arranged before his laboratory was to be thrown open for public inspection and the light given to the world for better or for worse.

There occurred, however, at this juncture a discovery that materially changed the system and gave a rapid stride toward the perfect electric lamp. Sitting one night in his laboratory reflecting on some of the unfinished details, Edison began abstractedly rolling between his fingers a piece of compressed lampblack mixed with tar for use in his telephone. For several minutes his thoughts continued far away, his fingers in the meantime mechanically rolling out the little piece of tarred lampblack until it had become a slender filament. Happening to glance at it the idea occurred to him that it might give good result as a burner if made incandescent. A few minutes later the experiment was tried, and, to the inventor's gratification, satisfactory, although not surprising results were obtained. Further experiments were made, with altered forms and composition of the substance, each experiment demonstrating that at last the inventor was upon the right track.

A spool of cotton thread lay on the table in the laboratory. The inventor cut off a small piece, put it in a groove between two clamps of iron and placed the latter in the furnace. The satisfactory light obtained from the tarred lampblack had convinced him that filaments of carbon of a texture not previously used in electric lighting were the hidden agents to make a thorough success of incandescent lighting, and it was with this view that he sought to test the carbon remains of a cotton thread. At the expiration of an hour he removed the iron mould containing the thread from the furnace and took out the delicate carbon framework of the thread—all that was left of it after its fiery ordeal. This slender filament he placed in a globe and connected it with the wires leading to the machine generating the electric current. Then he extracted the air from the globe and turned on the electricity.

Presto! a beautiful light greeted his eyes. He turns on more current, expecting the fragile filament instantly to fuse; but no, the only change is a more brilliant light. He turns on more current, and still more, but the delicate thread remains entire. Then, with characteristic impetuosity and wondering and marvelling at the strength of the little filament, he turns on the full power of his machine and eagerly watches the consequence. For a minute or more the tender thread seems to struggle with the intense heat passing through it—heat that would melt the diamond itself—then at last it succumbs and all is darkness. The powerful current had broken it in twain, but not before it had emitted a light of several gas jets. Eagerly the inventor hastened to examine under the microscope this curious filament, apparently so delicate, but in reality much more infusible than platinum, so long considered one of the most infusible of metals. The microscope showed the surface of the filament to be highly polished and its parts interwoven with each other.

It was also noticed that the filament had obtained a remarkable degree of hardness compared with its fragile character before it was subjected to the action of the current. Night and day, with scarcely rest enough to eat a hearty meal or catch a brief repose, the inventor kept up his experiments, and from carbonising pieces of thread he went to splinters of wood, straw, paper, and many other substances never before used for that purpose. The results of his experiments showed that the substance best adapted for carbonisation and the giving out of incandescent light, was paper preferably thick like cardboard, but giving good results even when very thin. The beautiful character of the illumination and the steadiness, reliability and non-fusibility of the carbon filament were not the only elements incident to the new discovery that brought joy to the heart of Edison. There was a further element—not the less necessary because of its being hidden—the element of a proper and uniform resistance to the passage of the electric current.

The inventor's efforts to obtain this element had been by far the most laborious of any in the history of his work from the time he undertook the task, and without it absolute success to electric incandescent illumination could not be predicated, even though all the other necessary properties were present in the fullest degree.

Passing over the scores of experiments made since the discovery that the carbon framework of a little piece of paper or thread was the best substance possible for incandescent lighting, we come to consider the way in which the same is prepared at the present time in the laboratory.

With a suitable punch there is cut from a piece of "Bristol" cardboard a strip of the same in the form of a miniature horseshoe, about two inches in length and one-eighth of an inch in width. A number of these strips are laid flatwise in a wrought iron mould about the size of the hand and separated from each other by tissue paper. The mould is then covered and placed in an oven, where it is gradually raised to a temperature of about six hundred degrees Fahrenheit. This allows the volatile portions of the paper to pass away. The mould is then placed in a furnace and heated almost to a white heat, and then removed and allowed to cool gradually. On opening the mould the charred remains of the little horseshoe cardboard are found. It must be taken out with the greatest care, else it will fall to pieces. After being removed from the mould it is placed in a little globe and attached to the wires leading to the generating machine. The globe is then connected with an air pump, and the latter is at once set to work extracting the air. After the air has been extracted the globe is sealed, and the lamp is ready for use. Figure 5 shows the lamp complete:—

A is a glass globe, from which the air has been abstracted, resting on a stand, B. F is the litttle carbon filament connected by fine platinum wires, G G^1, to the wires, E E^1, leading to the screw posts, D D^1, and thence to the generating machine. The current, entering at D, passes up the wire E to the platinum clamp, G; thence through the carbon filament F to G^1, down the wire E^1 to the screw-post D^1; thence to the generating machine. It will be noticed, by reference to the complete lamp in Fig. 5, that it has no complex regulating apparatus, such as characterised the inventor's earlier labours. All the work he did in regulators was practically wasted, for he has lately realised that they were not at all necessary—no more so than a fifth wheel is to a coach.

He finds that the electricity can be regulated with entire reliability at the central station, just as the pressure of gas is now regulated. By his system of connecting the wires the extinguishment of certain of the burners affects the others no more than the extinguishment of the same number of gas burners affects those drawing the supply from the same mains. The simplicity of the completed lamp seems certainly to have arrived at the highest point, and Edison asserts that it is scarcely possible to simplify it more. The entire cost of constructing them is not more than twenty-five cents.

The lamp shown in Fig. 5 is a table lamp. For chandeliers it would consist of only the vacuum globe and the carbon filament attached to the chandelier, and connected to the wires leading to the generating machine in a central station perhaps a half-mile away, the wires being run through the gas pipes, so that in reality the only change necessary to turn a gas jet into an electric lamp is to run the wires through the gas pipe, take off the jet, and screw the electric lamp in the latter's place. Although the plans have been fully consummated for general illumination, the outline of the probable system to be adopted is the locating of a central station in large cities in such a manner that each station will supply an area of about one-third of a mile. In each station there will be, it is contemplated, one or two engines of immense power, which will drive several generating machines, each generating machine supplying about fifty lamps.

[Edison's generating machines have been previously described. See *Electrician*, vol. iii., p. 272.]

The apparatus for measuring the amount of electricity used by each householder is a simple contrivance consisting of an electrolytic cell and a small coil of wire, appropriately arranged in a box, the latter being of about half the size of an ordinary gas meter, and like a gas meter it can be placed in any part of the house. The measurement is obtained by the deposit of copper particles on a little plate in the electrolytic cell, such deposit being caused by the electric current passing through the cell. At the end of any period, say one month, the plate is taken by the inspector to the central office, where the copper deposit is weighed and the amount of electricity consumed determined by a simple calculation.

In addition to the various parts of the system above described, there are a number of other details, not so important to be sure as those of which sketches have been given, but nevertheless essential to make up the complete plan of economical electrical illumination. A description of these latter will not be attempted, as a proper understanding of them involves a technical knowledge of the laws of electricity. The entire system embraces an amount of work so extensive that one naturally wonders how a single man in such a brief space of time as fifteen months could possibly have planned and perfected it all. And surprise becomes greater when it is considered that during this period Edison found time to make other inventions. A sextuplex telegraph, or apparatus for sending six messages on one telegraph wire in opposite directions simultaneously, saw life during the progress of the electric light, patents for the same having only just been issued. Several new and important improvements in his chalk telephone, by which the efficiency of that invention is greatly increased, also attest his industry and versatility of genius.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.

The seventh ordinary general meeting of the shareholders in this Company was held on Thursday, the 8th inst., at the City Terminus Hotel, Cannon-street, under the presidency of Sir E. W. Watkin, M.P.

The Manager (Major A. Wood) read the advertisement convening the meeting, and the minutes of the last meeting, which were confirmed as correct and signed by the chairman. The report of the directors was taken as read. After referring to the sudden death of the late chairman, Mr. Henry Rawson, to the retirement of Mr. John Bibby and Mr. James Higgins, and the election as directors of Sir E. W. Watkin, Mr. Sam Mendel, and Mr. Henry Cooke, of Manchester, it stated, *inter alia*, that the receipts for the past year amounted to £92,733, showing a decrease of £148, as compared with the previous year. Under the agreement between this Company and the Brazilian Submarine Company, the latter, as reported to the shareholders last year, raised the question whether, owing to the long and repeated interruptions of the traffic, this Company was entitled to share in the revenue of the Brazilian Submarine Company during the continuance of such interruption. The directors agreed to compromise this question, and consented to deductions to the amount of £7,069. But for this loss and others of smaller amount, owing directly to interruption of traffic, the revenue would have reached a sum of £106,882. With respect to the contention of the Brazilian Submarine Company, that the question of the division by thirds of the respective revenues of the two companies is referable to arbitration under the existing agreement, the directors had been strongly advised that such contention was untenable, and were resisting it accordingly. The expenses this year on general account, excluding interest and rebates on debentures amount to £27,615, as compared with £31,297 for last year, showing a decrease of £3,632. The measures referred to in the last report had resulted in placing the lines in complete working order throughout for the first time last February. As intimated in the same report, "a very great permanent improvement in the lines has been effected, but more work remains to be done in the same direction." This anticipation had been borne out by the result, for, although where renewed with sheathed cable the lines had remained in good order, the faulty portions had continued to give out from time to time. The cost of maintenance and of renewals effected during 1377-78 amounted to £69,194, of which £38,194, was charged direct to revenue, and £31,000 to renewal account. In the year 1878-9 the outlay had been £72,104. The directors proposed to charge direct to revenue £24,270, under the head of maintenance, and to carry the balance of revenue, amounting to £19,926 to renewal account. This, with the balance standing to the credit of that account, and the balance of revenue from last year of £3,263, making together £43,866, would leave a balance of £3,967 to carry forward as a debit to the renewal account of the current year. The true policy of the Company was at once to set to work promptly to relay the whole of the faulty cable in a most substantial and permanent manner. The s.s. Norseman had had to be ordered home for new engines, and to undergo thorough

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repair. The Board were making arrangements to carry out this work, and hoped that the Norseman would be ready to return to her station about March next. She should take out with her the cable required to continue the renewal of the system. Meanwhile the s.s. International, on charter from the India Rubber, Gutta Percha, and Telegraph Works Company remained out in the Brazils to effect repairs. As soon as this ship could be sent home a large economy will be secured. The result of the operations thus far conducted had been to substitute, at the cost of revenue, sheathed cable for the faulty type for a distance in all of 790 miles, out of a total of 2,845 miles, or, in other words, to renew more than one-fourth of the system. The receipts for the first ten weeks of the current quarter averaged £2,900 per week, being at the rate of £152,279 yearly, leaving (after payment to the Platino-Brazileira Company) £126,490 as the revenue of this Company.

The CHAIRMAN, in moving the adoption of the report, and the statement of accounts, said he had very few remarks to make with regard to them, because of course they were the records of the proceedings of the gentleman who preceded him, but to summarise the thing very shortly, it practically came to this—that although the cable was stopped and interrupted on a great many occasions during the year, still there was a gross revenue of £92,000, leaving a net revenue of about £40,000, after charging £24,000 to the renewal of cables. It was generally calculated that a cable should be worked from one year to another at a cost of about 25 or 30 per cent. Their cable, on the other hand, had been worked during the year at a cost of 60 per cent. That had been because they had no margin of capital and on account of very extensive renewals to the cables in different parts of their system. In order to cure this, and to bring about that sound state of things in which the ordinary stockholder received his share of the net profits, it was necessary first to pay their debts, secondly to complete the renewal of the cable, and thirdly to have a reasonable margin of security. Now, he had proposed a scheme to the proprietors, the object being to make them their own mortgagees. That scheme, no doubt, involved paying a high rate of interest, and somewhat onerous terms. He was happy, however, to say—because it showed that the proprietors were largely disposed to help themselves—that a very considerable response had been made to that appeal—a response which justified one in believing that if Mr. Mendel, Mr. Cooke, himself, and their colleagues had exerted themselves they might have got the whole of the money on the terms proposed. A number of gentlemen, however, who were considerably interested thought that by co-operating with gentlemen now largely interested with the company in various ways, the amount required might be raised at 6 per cent. instead of 7 per cent., and that the 6 per cent. bond might be redeemable at par instead of, as he had proposed, redeemable at 10 premium. Of course, what each of them wanted—or ought to want—was to do the best he could for the undertaking. It was absolutely essential to get out of debt, and it was even more essential than that that the cable should be made firm and sound, so that instead of earning £92,000 they might earn twice as much if possible; and he did not think that absolutely impossible. If they had thoroughly sound cables they would do so—at all events, he was so advised by those who ought to know more about it than he. He, therefore, under these circumstances, thought to some extent that his own views should be subordinated to the views of those who expressed their readiness to come forward and assist them. He was then only speaking of the principle of the arrangement, and he thought he might say as to that that the directors had made such arrangements as would provide the capital to pay off the whole of their present debt, for renewing their cables, and also for meeting the various classes of debentures that would fall due next August. If these arrangements, which were accepted in principle, did not break down in detail—and he had no reason to anticipate that any such event would happen—he thought they might say, probably for the first time, that they were out of debt, that they were in a position to renew and repair their cables, and that before many months were over that share of the net revenue which would exist over and above the payment of the interest on the bonds would be distributed in dividend to the ordinary proprietors. He thought, on the whole, that they would say, considering the many difficulties against which they had had to contend, but with which he need not trouble them, that that was not, on the whole, an unsatisfactory state of things to report. There was another matter which had exercised some of their minds. It was the apparently hostile action of the Brazilian Government, or rather the Brazilian officials, with respect to the land lines and competition. Their secretary, Mr. Cunningham, was now out in Brazil, and he had reported to them that he had had satisfactory interviews with members of the Government—he believed it was the Minister of Agriculture who had charge of these things—and that he thought he had almost completed an arrangement with the Government of Brazil which he (the chairman) hoped would get rid of all possible antagonism between them. Under these circumstances, if they had peace at home, and consolidated concessions in Brazil, he thought, on the whole, they might rather congratulate themselves. He did not wish to say more on that occasion, because he had known a great deal of harm done through too much being said when negotiations with foreign governments were going on, and such delicate matters were on the *tapis*. He thought that what he had said was not altogether unsatisfactory. He then moved the resolution.

Mr. MENDEL seconded the motion, which was at once carried unanimously.

On the motion of the CHAIRMAN, the retiring directors, Messrs. Cross and Andrews—the former of whom represents the Lancashire shareholders—were re-elected.

Mr. W. C. QUILTER next moved, and Mr. W. FORD seconded, the re-election of the retiring auditor, Mr. Weise, and the motion was also carried unanimously.

Mr. ALEXANDER BEATTIE then referred with regret to the loss sustained by the Company in the death of the late chairman, Mr. Henry Rawson. He thought the meeting should not separate without passing a resolution expressing such regret, and also sympathising with the relatives of the deceased gentleman in their bereavement. He concluded by moving a resolution to that effect.

The CHAIRMAN said he could most cordially support Mr. Beattie's resolution, which he was sure Major Wood would draft and transmit. He knew that Mr. Rawson connected himself with that undertaking at a time of extreme difficulty, acting more from duty than from any personal pleasure or inclination, and he was confident that he endeavoured to discharge his duties to the utmost of his ability. He felt sure that it was unnecessary to go through the formality of submitting such a resolution to the vote, and that they might consider it as passed unanimously.

A SHAREHOLDER then suggested the advisability of holding half-yearly meetings.

The CHAIRMAN, in reply, said he always believed in frequent meetings, and especially in cable concerns. Things moved about so rapidly and frequently that he thought the more often the directors came face to face with their constituents the better. He would promise them that they should have a half-yearly meeting in July on two conditions—that they had something very bad or something very good to report, but he thought the latter was most probable.

On the motion of Mr. BEATTIE a vote of thanks was passed to the chairman and directors, and

The CHAIRMAN having briefly acknowledged the compliment, the proceedings terminated.

TELEGRAPH SHARE LIST.

COMPANIES.	CLOSING PRICES JAN. 7.		BUSINESS DONE WEEK ENDING JAN. 7. Highest.	Lowest.
Anglo-American Ordinary	58⅜,	9½	59⅜	57½
Do. "B"	83½,	⅛	83⅜	82⅜
Do. "A"	34,	½	35	33
Brazilian ex div.	7½,	⅝	7 9-16	7 7-16
Cuba	8½,	9	8⅞	8⅞
Do. Ten per Cent. Preference	15½,	16½	15½	15½
Direct Spanish	1⅜,	2¼	2⅛	2
Do. Ten per Cent. Preference	10½,	11½	11⅝	11
Direct United States	11,	¾	11⅜	10½
Eastern	8 9-16,	11-16	8⅞	8⅝
Do. Six per Cent. Debenture	102,	4	104¾	104¾
Do. Five per Cent. do	102,	4	—	—
Do. Six per Cent. Preference	11 13-16,	15-16	12	11⅞
Eastern Extension	8½,	⅝	8⅝	8½
Do. Six per Cent. Deb.	106,	9	108	107
German Union	8¾,	9½	9	8⅝
Globe Telegraph and Trust	5⅛,	¼	5 5-16	5 1-16
Do. Six per Cent. Preference	11½,	⅜	11⅜	11¼
Great Northern ex div.	8⅞,	9⅛	9⅛	8⅞
Indo-European	22½,	3½	—	—
Mediterranean Extension	2⅜,	3½	—	—
Do. Eight per Cent. Preference	10,	½	—	—
Reuter's	10,	11	—	—
Submarine	230,	5	—	—
West India and Panama	1⅝,	¾	1 11-16	1⅝
Do. Six per Cent. Preference	7½,	¼	—	—
Western and Brazilian	5⅜,	⅝	5⅝	5½
West. Union Seven per Ct. 1st Mt.	120,	5	123½	121
Do. Six per Cent. Sterling	105,	7	106¾	106¼

TRAFFIC RECEIPTS FOR DECEMBER, 1879.

COMPANIES.	Dec. 1879.	Dec. 1878.	Incrse.	Decrse
Cuba Submarine Company	3,000 estd.	3,095	—	95
Direct Spanish Telegraph Company	1,551	940	611	—
Eastern Telegraph Company	45,704	38,467	7,237	—
Eastern Extension Telegraph Company	26,025	22,929	3,096	—
Great Northern Telegraph Company	16,933	—	—	—

ADDRESSES.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

PETER BROTHERHOOD, Engineer, 56 and 53, COMPTON-STREET, GOSWELL-ROAD, E.C.
Specialities—Patent 3-Cylinder Engines (Silver Medal, Paris), as used by Siemens, Gramme, and Wilde for driving Electric Machines.

RANSOMES, SIMS, and HEAD, Orwell Works, IPSWICH.
Specialities—Portable and Stationary Engines, fitted with patent governors, as tried in the electric lighting experiments on the Thames Embankment.

ABBOTT and Co., NEWARK-ON-TRENT.
Specialities—The "Standard Size" Vertical Cross Tube Boilers. Illustrated catalogue, giving every detail of a variety of Boilers, 2s. 6d., post free.

CARBON ELECTRODES COMPANY. Works: 39, COMMERCIAL-ROAD, EAST.
Specialities—Carbon Rods of all sizes for Electric Lighting. Also, Plates and all other Moulded Carbon Goods. List of prices on application.

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SLIP

MAGNETIC DECLINATION.—A map showing lines of equal magnetic declination for 1880 was given in the *Colliery Guardian* of Jan. 9.

EASTERN TELEGRAPH COMPANY.—The next ordinary meeting will be held on Thursday, January 22nd, at the Cannon-street Hotel.

WIRE GAUGE.—The report of the Committee of the Society of Telegraph Engineers on the Birmingham wire gauge has just been issued.

TELEPHONE FOR MILITARY WORK.—The Austrian Minister of War has ordered the telephone to be tried in transmitting orders from one fort to another.

THE SS. GREAT NORTHERN.—This ship, long the property of Messrs. Hooper, has been purchased for the Eastern and South African Telegraph Company.

EDISON'S LAMP.—Mr. Edison has set himself, we hear, to construct a portable electric lamp (comprising a constant battery for supplying the current) which shall be no larger than an ordinary moderator lamp.

OXIDATION OF ALCOHOLS BY ELECTROLYSIS.—Mr. A. Renard has written a long paper on this question, describing his experiments, of which an abstract appears in the current number of the *Chemical Society's Journal*.

WIRE.—The greater portion of the wire used in cable work is supplied by Germany. This is partly due to the fact that the cost of carriage by water from Cologne is less than the cost of carriage by rail from Manchester.

NICKEL PLATING.—The *Electro Metallurgist* understands that the Government have adopted nickel plating at their small arms manufactory at Enfield for the purpose of protecting gun barrels from oxidation when transmitted abroad.

WERDERMANN'S ELECTRIC LIGHT.—This light is now to be employed in lighting the whole *foyer* of the Opera House. These lamps are ornamental, and six are fed by one Gramme machine. Their photometric power is, however, not given.

EDISON'S LAMP.—The *Scientific American* of January 10th contains a description of this lamp, but gives no more information than was given by us in our last issue. The illustrations, as is always the case in this paper, are admirable.

THE NEW FRENCH CABLE.—We are frequently asked for information as to this cable, but have invariably to reply that we are ignorant as to the time of opening. It has been rumoured that the delay arises because of a "fault" in the cable.

THE TELEPHONE.—On the afternoon of Jan. 7th telephonic communication was successfully established on the South-Eastern Railway between the office of the station master at Charing Cross and that of the station master at Cannon street, a distance of two miles.

PROGRESS OF ELECTRIC LIGHTING.—The Newport Alexandra Dock Company are about to extend the electric light at their docks, and propose to light up the coal hoists by its means, in order that the work of shipping coal may be carried on both day and night when necessary.

LIVING LIVES.—It may be in the recollection of our readers that a few weeks since we gave an extract from this publication referring to the biography of Sir James Anderson. The work is now issued with photographs. It contains five short but readable biographies, and is well printed and bound.

THE TELEPHONE EXCHANGE IN LEEDS AND BRADFORD.—A telephonic line for the Corporation of Bradford has been erected on the Bell system, between the Borough Accountant's office at the Town Hall and the Gas Works. The Leeds Corporation have under consideration the advisability of adopting this mode of communication between their various reservoirs, police-stations, &c.

THE BRAZILIAN CABLES.—These, originally of Hooper's core, and designed for a deep sea Atlantic route from England to New York, *viâ* Bermuda, but laid in shallow water along the Brazilian coast, are being replaced by gutta percha cable whenever repaired, and 400 miles of gutta percha cable is to be ordered for further renewals. Some of the faults are attributable to the sheathing being unsuited for shallow water, and others to the nature of the core.

WANTED, A HOUSEHOLD MOTOR.—From the numerous enquiries which have been addressed to us from different parts of the country, as to where and at what price the small electric motor of M. Deprez for household purposes can be obtained, we think it only fair to infer that there is a neat, cleanly, and economical little electric motor for home uses, such as driving a sewing machine or coffee mill, which would be welcome to certain classes of the community. Will our electric mechanicians take the hint?

LA LUMIERE ELECTRIQUE.—We are glad to see that our excellent contemporary is to be published twice a month, instead of once a month as heretofore. In the current number Count Th. du Moncel describes at considerable length the mode of applying electricity to organs. He also expresses his opinion on Edison's new lamp, as will be seen from the abstract in another column. We notice also articles on submarine telegraphy, M. Perruchi's electric lamp, M. de Goarant's distance measurer, as well as notes on recent electrical work.

EFFECTS OF LIGHTING.—In a severe thunderstorm in the Land's End district one of the flashes of lighting struck Brew farmhouse (occupied by Mr. Robert Humphreys), entered the kitchen, destroyed the slab, tore away the plaster from the wall, and smashed the kitchen window. The servant girl, who was in the kitchen at the time, was paralysed by the lightning, and has not yet recovered. A man who had taken shelter under a hedge near the farm was knocked from under the hedge into the farm garden; and a man and horse standing in the vicinity of the house were both struck down.

CONDUCTIVE ALLOYS.—It was shown a few years ago by Dr. Obach that alloys of the metals proper, such as lead and tin, potassium and sodium, and sodium amalgam, conduct a current without being decomposed; and it has recently been demonstrated by Herr Elässer that alloys of the metals with the half-metals (?) antimony and bismuth also conduct without decomposing. He further remarks that the transition from these conductors to electrolytes is not a sudden one. Between the two groups are substances, such as copper, silver, lead, nickel, iron, bismuth, tin, and antimony sulphides, which are simple conductors at a low temperature and electrolytes at a high one.

SIR ROWLAND HILL MEMORIAL.—A telegram of the Lord Mayor, in behalf of the "Sir Rowland Hill Memorial Fund," has been despatched to all parts of the world connected by the submarine telegraph system over which Mr. Pender, M.P., presides, namely, Turkey, Egypt, India, South Africa, China, Straits Settlements, Australia, and America; and the replies already received from the Mayors and representatives of the cities to which the message was forwarded, express warm interest and sympathy with the object in view, all testifying to the boon conferred upon mankind by the intro-

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duction of cheap postage, of which Sir Rowland Hill was the originator.

MORTON AND EDISON.—The following is given as Mr. Edison's reply to Prof. Morton's adverse criticism :—"Every word that was printed in the article of the *New York Herald* is literally true, although it was printed without my knowledge. Professor Morton does not read between the lines; he should investigate first and animadvert afterwards. I now authorise to extend an invitation to him or any other electrician to visit my laboratory and see the light in practical operation. No impediments will be thrown in their way. Everything shall be open and above board. If men, however, are wilfully blind I cannot undertake to restore their sight." *Nous verrons.*

A VESSEL FINED FOR BREAKING A TELEGRAPH CABLE.—The *Alta California*, of November 21st, says that "The Western Union Telegraph Company have obtained judgment in a justice's court against the schooner Dreadnought for breakage of their submarine cable in Oakland." The *Nautical Magazine* observes that "shipmasters should carefully avoid bringing up in the vicinity of, and between, the buoys that mark the position of such cables. Besides the possible detention of the ship on behalf of the telegraph company, the breakage of a cable may (at times) seriously interfere with commercial and political transactions."

THE SINGING CONDENSER IN VACUO.—It is well known that if the poles of a condenser made of loose leaves of tinfoil be connected to the secondary of an induction coil the condenser will vibrate in time with the alternate currents of the coil, and emit a slight hum or droning sound. This drone will gradually disappear if pressure be exerted on the leaves of the condenser; and it has been proved by M. Trève that it disappears when the pressure is such as to drive all the air from between its leaves. M. Trève put a Fizean condenser into a Geissler tube and connected it to the poles of a secondary coil by means of the electrodes of the tube. He then exhausted the air from the tube till the pressure was only 0·003 or 0·004 metre of mercury, and the sound was entirely silenced; but strange to say a white and brilliant light appeared giving a pearly sheen to the foil of the condenser; and quite distinct from the ordinary vague phosphorescence of the Geissler tubes.

ARTIFICIAL DIAMONDS.—The alleged diamonds of Mr. Mactear have been examined by Mr. Crookes in his electrified vacuum. It will be remembered that, in his recent researches on "Molecular Physics in High Vacuo," Mr. Crookes found that the molecular rays have power to produce phosphorescence in bodies on which they fall, and that the only body which surpassed Becquerel's luminous sulphide in this respect was the diamond, which glowed with various tints, according to the kind, such as blue, yellow, apricot, green, and orange. Mr. Crookes also finds the artificial crystals of Mr. Mactear to phosphorise brightly with different colours, which are strikingly similar to the hues emitted by the small rough Brazilian diamonds, known in the trade as "Boart." The crystals themselves are small, and irregular in shape, and from 1 mm. in diameter downward, mixed with larger fragments from 3 to 4 mm. across. They are whitish and clear. It should also be mentioned that Mr. Mactear has had a personal interview with Prof. Maskelyne, with the result that the latter has receded somewhat from his former repudiation of the gems.

TELEPHONIC EXCHANGE.—The following paragraph occurs in a letter in the *Manchester Examiner* :—"There are two telephonic exchange companies in Manchester, and there are hundreds of commercial houses who are satisfied that sooner or later they must join one or the other of them. Is there no way of solving the question as to which they should join except waiting to see which succeeds the better of the two? If the two companies have equally efficient instruments there ought to be little doubt about it. The one charges £20 a year and the other £12, and one or two hundred names given to the cheaper would perhaps settle the question. But we are not all scientific, and we cannot all speak with authority. If we are all to join a telephonic exchange—and I think most of the large commercial houses think we must—why not do so in the year 1880 instead of 1890." It is seldom that advice from strangers is followed except when it agrees with preconceived conclusions, and therefore we do not care to offer it, yet we may ask how it is that one system should cost £8 a year more than the other? It certainly does not arise from more costly apparatus, for we opine that the first cost of the apparatus on Bell's system is really less than that on Edison's. Singular to say, the charge from the Edison company is less than that of its competitor.

TELEGRAPHING THE TAY BRIDGE DISASTER.—Any event of an extraordinary character is almost sure to test to the full the capabilities of our telegraphic system. The requirements of the Press are so pressing that time is of the utmost importance. Such a catastrophe as that at the Tay Bridge calls for all the efforts that the telegraphic staff can put forth. It is stated that the Dundee staff was reinforced, and even then many of the clerks were on duty for fifteen hours at a stretch. Five fast-speed Wheatstone instruments were kept going at the rate of about 100 words per minute, being fed by ten "punches" for perforating the ribbon. During the week ending on Wednesday, Jan. 7, news to the amount of about 250 columns of ordinary printed newspaper matter was sent along the wires from Dundee, but as many of the messages were sent to perhaps half a dozen newspapers this would represent at least 1,000 columns of news presented to the public in the largest towns of the country. The heaviest day's work at the Dundee Telegraph Office appears to have been Monday, the 5th inst., the second day of the Board of Trade inquiry, when the enormous number of ninety thousand words, or forty-five columns, were telegraphed, making, when published, about 180 columns. Mr. Gibb and his staff well deserve praise for the excellent manner in which they performed their duties.

FORMATION OF HYDROCYANIC ACID IN THE ELECTRIC ARC.—It will be remembered that Professor Dewar read a paper at the late meeting of the British Association on the Synthesis of Hydrocyanic Acid, and another on the Amount of Nitrous Acid Produced in Electric Illumination. We seek in vain for abstracts of these papers in the report of the British Association, and fear that Professor Dewar consulted his own ease, but not the public welfare, in neglecting to make an abstract. The following abstract, from the *Chemical Society's Journal*, however, has some bearing upon the subject:—From the statements made by Plucker, Angström, and Thalèn, that the so-called carbon lines are invariably associated with the formation of acetylene, the author made experiments with a view to extract this substance from the electric arc, which shows this spectrum at the positive pole when the electric current is powerful and occasionally intermittent. The carbons were used in the form of tubes, so that air could be drawn through them, and so that any gas might be passed up one tube and drawn down the other and then examined. A Siemens and a De Méritens magneto-machine were employed. In the first experiment a current of air was drawn down the negative pole and passed through

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solutions of potash and potassium iodide and starch. No nitrates were indicated, but the potash solution contained sulphides. In the second experiment, in which hydrogen was led in by the positive pole and withdrawn by the negative, acetylene was found by the ammoniacal sub-chloride of copper test, whilst water, through which the gases were passed, gave distinct evidence of hydrocyanic acid. The hydrogen flame burning alone gave no evidence of these substances. Air drawn through the negative pole gave considerable quantities of hydrocyanic acid; but when drawn through the positive pole a larger proportion was found, whilst the same carbons used with De Meritens' magneto-machine gave no result. If the carbons are not purified, hydrogen sulphide is always found along with the other compound. The author concludes that the high temperature of the positive pole is required to produce the hydrocyanic acid, which is, in all probability, formed by the free nitrogen reacting on the acetylene thus:— $C2\ H2 + 2N = 2HCN$, and that the hydrogen to form the acetylene is obtained from the decomposition of aqueous vapour, and from the combined hydrogen in the carbons.

The Manchester City Council on Telegraphic and Telephonic Wires.—On the motion for the confirmation of the minutes of the paving, sewering, and highways committee, at the meeting of the council on Jan. 8, Mr. Alderman Lamb said he wished to ask the chairman of the committee whether any steps had been taken for regulating the placing of telegraphic or telephonic wires over the streets. They were all aware that hundreds, if not thousands, of these wires had been put up; and he believed that this number was nothing in comparison with the number that would be put up in the future. He should be sorry to throw any obstacle in the way of scientific improvements, especially such as had a tendency to facilitate the transaction of business; but he thought the time had come when the erection of so many wires called for official and systematic supervision. The wires seemed now to be fixed without regard to public safety. The permission of the owners of the property to which the wires were attached had to be obtained, and that was all that was required. It was well known that any sudden storm or change of temperature, by expanding or contracting the metal, did mischief to the telegraph wires. Only last week he saw a wire hanging down broken from a high warehouse not far from that building. They could imagine the serious consequence which would follow if such a wire hung down in a public thoroughfare such as Mosley-street, where omnibuses were continually passing, on a dark, foggy day or a dark night. The consequences might be fatal. He thought the wires, instead of being fixed anyhow as at present, should be in block, and, as far as possible, underneath the streets.—Mr. Alderman Thompson said the wires crossing the streets were very largely connected with telephones, and their numbers would increase very largely and rapidly unless some check were imposed. They constituted a serious danger to the public, but the question could not be hastily dismissed. They had to look on the one hand at the danger to the public, and the convenience of private persons. He believed that many of the property owners who had permitted wires to be attached to the roofs of their buildings were regretting that they had done so, for he understood the vibration was so great that whatever care was taken it was impossible to prevent the roofs becoming faulty in a very short time.—Mr. Alderman Heywood, in replying, said that the question had already been considered by the highways committee, who had intimated to the Post Office authorities where they should erect the posts so as to secure the wires being laid at right angles to the streets. If any suggestion came from that Council it must be in the direction of securing the observance of this rule of laying the wires at right angles to the streets, and then he thought the fear entertained by Mr. Lamb would not be realised. He trusted the Council would not do anything to interfere with the marked progress which these wires indicated. They marked an era in the advance of civilisation.

The New French Cable.—It is not often that our contemporary *Iron* gives us cause to grumble that papers professing science are not scientific; but the following paragraph shows that the writer is not acquainted with submarine telegraphy. Leaving out the printer's error by which conductivity appears as "conductiority," we would humbly ask how ten copper wires twisted round a central wire ensure absolute conductivity in all "*weather*." There are several other points needing elucidation, but our readers will have no difficulty in finding them:—"The new French Cable Company, which, but a few months since, existed only in the minds of its promoters, is now a *fait accompli*, and is flashing under the ocean the congratulations of two continents. This company, profiting by the costly experiences of its predecessors in this formerly unexplored field, has been enabled to combine in the construction and submerging of its cable all the improvements that science has been able to offer; and from the moment of its inception to the hour its cable was successfully landed on Eastham Beach, not one hitch occurred in its arrangements—so perfect were they in every detail. Indeed, as the President of the American Union Telegraph Company stated, in the first message sent through the new cable to the President of the French Company, in respect of this achievement 'both as regards rapid construction—as well as perfect insulation, there is no parallel in cable history, it being only just seven months from the very day, the 17th of November, since the concession of the company was granted by the French Government.' The cable proper, which is the work of Messrs. Siemens Brothers, of London, who, it will be remembered, also constructed the English Direct Cable, is stronger and heavier, and is considered more perfect than any other in use. A central wire of copper is surrounded by ten copper wires, twisted, thus ensuring absolute conductiority in all weather. For insulating purposes, three envelopes of gutta-percha surround the wire, and outside of the gutta-percha is placed a wrapping of Manilla hemp, treated with Chatterton's Compound. An armour of steel wire, for protection, is placed outside the hemp, the wires composing its armour being laid in a peculiar manner, side by side, so that fracture seems almost impossible to occur. Surrounding the wire covering is a second of manilla hemp, saturated with an anti-corrosive compound; which makes assurance doubly sure that the cable will always be ready for use. The new Franco-American cable extends from Brest to St. Pierre, Miquelon, Finistère, and from St. Pierre to North Eastham, Massachusetts, where it will connect with the wires of the American Union Telegraph Company. The Faraday, which has been engaged in laying the new cable, will now return to Brest, when another cable of similar character will be laid thence to the Land's End, thereby establishing a telegraphic connection with England. Next year the French Company will lay another cable from the Land's End to St. Pierre, thus securing a double line between Europe and America. It is an interesting fact that the first despatch received in America from the Faraday announcing the perfect condition of the cable when that vessel had arrived within twenty miles of the shore, was sent by the round-about way of France, and back again by the Anglo-American cable."

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A SYSTEM OF ELECTRICAL STORAGE.

BY PROFS. EDWIN J. HOUSTON AND ELIHU THOMSON.

The various suggestions which have hitherto been made for the storage of electrical energy, in such manner as to readily permit its after recovery in the form of electrical current, have failed when attempted to be carried into practice, either on account of their inherent impracticability, or by reason of the serious inconveniences and losses due chiefly to the following:—

1st. The extent of conducting surface of the storage apparatus required to be acted on, rendering it cumbrous.

2nd. The loss of energy due to evolution of gas during the operation of charging.

3rd. Lack of constancy and duration in the currents evolved after charging.

4th. The limited capacity for storage due to the proportion of active material being but a fraction of that present.

The well-known Planté secondary battery is open to all of the above inconveniences, and though admirable in its conception as a piece of scientific apparatus, yet lacks markedly the requisites of an economical reservoir for electrical action. In the secondary battery, as is well known, the duration of action is chiefly dependent upon the amount of surface of the lead plates employed; the action of the current used to charge it being practically limited to the surfaces of the plates, and the charge received may therefore be designated as due chiefly to polarisation. Moreover, the charge received is necessarily limited on account of the evolution of gas.

It is manifest that a Smee cell, or cell with vertical plates, in an acid solution, could not be used in the process, for the only effect would be the evolution of the gases hydrogen and oxygen from the decomposition of water.

In the system of electrical storage devised by us, the duration of action and consequent capacity for storage is independent of extent of surface and dependent on the mass of material to be acted upon.

In our method we employ a saturated solution of zinc sulphate, enclosed in a suitable vessel, at the bottom of which is placed a plate of copper, to which is connected an insulated conducting wire. At or near the top of the vessel, and immersed in the solution contained therein, is placed a second copper plate, or plate of hard carbon, or metal unchanged by contact with zinc sulphate solution, and less positive than metallic zinc. This is also connected to a wire. The storage cell so constituted is then ready for charging, which is effected by the passage through the cell of a current, whose direction is from the lower to the upper plate. The current employed is that obtained from a dynamo-electric machine, and the result produced is the deposition of metallic zinc on the upper plate, and the formation of a dense solution of copper sulphate overlying the under plate. The duration of the charging action is, of course, limited only by the amount of zinc sulphate and the thickness of the lower plate. The cell, after charging, constitutes, in fact, a gravity cell, and continues a source of electrical current until a reconversion of all the copper sulphate into zinc sulphate has been effected, metallic copper being deposited on the lower plate, and the deposit of metallic zinc being removed from the upper. It thus may be allowed to regain its original condition. The recharging, however, may be effected at any time, either before or after the cell has become inactive. The cell may be covered or sealed to prevent evaporation; and, since no addition of new material is needed, a restoration to an active condition is at any time possible.

It is not necessary to employ zinc sulphate as the material to be decomposed, since other metallic salts may serve the same end, the only other requisite being that the lower plate shall yield to the solution a metal capable of redeposition, and the solution of which is denser than the solution employed in the cell, and that the upper plate be capable of receiving a metallic deposit and of retaining its form unchanged during prolonged use.

A (Fig. 1) represents a cell of glass, or other suitable material, furnished with two metallic plates, B and C, connected separately by conducting wires to the binding posts *b* and *c*, the wire from the lower plate being insulated. A porous diaphragm, E, is placed below the upper plate C, to prevent fragments of deposited zinc from falling on the lower plate, which may occur should the charging current be too intense.

In charging, the arrangement of the cells in multiple arc or in series may be adapted to suit the electromotive force of the dynamo-electric machine employed. The arrangement of the cells in charging may be different from that in discharging, according to the purpose for which the current is designed. Diffusive action of the solutions may be prevented by any of the well-known means used in gravity cells.

It may be objected that the economical results obtained in the storage of electricity as above described will necessarily be low, as but a fraction of the electrical energy in charging will be expended in overcoming counter electromotive force, or in effecting electrolysis, compared with that which overcomes the resistance of the liquid, and therefore lost in heat production. But this objection is readily met by so connecting the cells as to make their counter action or counter electromotive force the chief resistance to its passage. Economical results necessarily follow, the economy attained being measured by the relative cost of the fuel required to drive the dynamo-electric machine and that of the zinc and chemicals used for charging a battery of equal power to that of the storage battery used.

The resistance of the liquid between the plates of a storage cell may be lowered either by broadening the cell or by bringing the plates nearer together. In charging, economical results are obtained by using the plates comparatively near to each other, and separating them during discharge, and thereby avoiding loss by diffusion.

A convenient form of storage battery, designed for rapid charging and discharging, is shown in Fig. 2, where L, L′, L″, L‴ are horizontal plates of copper separated by insulating rings, W W, the spaces between the plates L, L′, &c., being filled with a saturated solution of zinc sulphate. Lateral tubes, *a*, are provided to compensate for the expansion of the liquid due to changes of temperature, and also to provide for filling the cells. The cells are held between plates E E by bolts which pass from one to the other. In this arrangement the plates L′ and L″ serve as upper and lower plates, accumulating copper sulphate on their upper surfaces and receiving metallic zinc on their under surfaces. The series may, of course, be extended.

When a number of cells are connected in series, several of them may be charging, while the remainder are used as a source of active current.

FIG 1

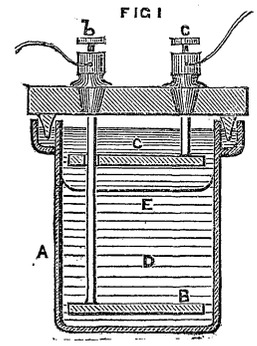
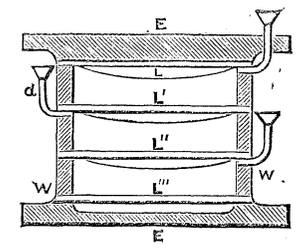


FIG. 2



The most obvious application of a storage battery furnishing a constant and lasting current is to replace the ordinary telegraphic batteries, the objections to the direct use of the dynamo-electric machine being mainly the necessity for continually sustaining the driving power and preventing variations or intermissions therein, to adapt the current generated to the work to be done, and to sustain a uniform electromotive force in said current. By the use of a storage battery the dynamo-electric machine may be run at suitable intervals to produce and sustain the charge of said battery. The economy and convenience of this arrangement will, we believe, be vastly greater than with the ordinary batteries in use.

In lighthouses, a dynamo-electric machine can be run by suitable power at intervals during the day to furnish an unfailing and reliable source of current for lighting purposes.

The purposes for which the storage batteries may be applied are so numerous that mention need not be made of them, the feasibility of each being decided by the question of its economy.

In domestic economy it would be feasible to provide storage batteries to be charged by dynamo-electric machines from convenient central locations, the energy of said batteries to be used in the operation of burglar and fire alarm systems, or for light driving power.

It is practicable in good forms of dynamo-electric machines to realise in external work from 50 to 60 per cent. of the power used in driving them. Of this we believe it possible to store and recover 50 per cent., or even more. Therefore 25 per cent. of the original power may be given out secondarily as electrical current. If it be assumed that in the best steam engines it is possible that 20 per cent. of the heat energy of the coal be utilised, then about 5 per cent. of the heat energy might, we think, be recovered after storage as electrical current. Notwithstanding this small percentage, the economy would be much superior to the employment of zinc and other materials used in the ordinary battery in the production of current.

Central High School, Philadelphia,
November 22nd, 1879.

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LITERATURE.

Lightning Conductors, their History, Nature, and Mode of Application. By RICHARD ANDERSON, F.C.S. [E. and F. N. Spon.]

There are several reasons why we have great pleasure in noticing this book. It is on an important subject, and one that is little understood; it is admirably printed, so that one feels he is not injuring his eyes by attempting to decipher it; then it is English and not American or a translation, whilst not the least factor in our pleasure is that we have not received a copy "for review."

We understand that Mr. Anderson has devoted a considerable amount of time during a period of seven years to the accumulation of the material for this work. He has prefixed to the main part of the book the titles of books consulted by him during his labours, and this list seems to exhaust the literature of the subject, giving as it does the works by English, French, German, Italian, and Swedish authors. The committee formed under the auspices of the Meteorological Society has been collecting information as to books, memoirs, &c., on this subject, but we doubt if that list is more complete than the one compiled by Mr. Anderson.

The introductory chapter tells us that the Greeks and Romans were acquainted with certain electrical phenomena, but no great step onward was made till the time of Dr. Gilbert, 1600, whose work was followed by that of Otto von Guericke (1650). Newton experimented as with a toy, Wall in 1708 said "that the light and crackling of rubbed amber seemed in some degree to represent thunder and lightning." Stephen Gray devoted his life to the study of electricity, Allamand, Musschenbrock, and Cuneus, between them made public the phenomena of the electric shock. The author refers to Watson's work, and deals out with no stinting hand deserved praise to Franklin. Our Royal Society, despising outsiders, read Franklin's letters, but published them not; Nollet in France at first refused to believe in the existence of the American, and afterwards derided his plans, keeping back by his influence for years the general introduction into Europe of the lightning conductor. An English manufacturer, who had learned the value of conductors in America, settled in France, and had one fixed to his house. The legality of the act was tried in the courts, and the result was favourable. "The lawyer who pleaded the case of the lightning conductors before the French tribunals at this momentous period was a very young man, quite unknown to fame at the time, but destined for a superabundance of it. His name was Robespierre." Dr. Watson was the first to set up a lightning conductor in England at his cottage at Gayneshill in 1762. Mr. Anderson describes their introduction over Europe, and various phenomena recorded as observed to result from thunderstorms; the whole of this portion of the work being extremely interesting. The seventh chapter deals with enquiries into lightning protection, and considers more especially the various reports of the Académie des Sciences, and is followed by one discussing the work of Sir W. Snow Harris. The last sentence of this chapter is suggestive. It is shown in the previous chapter that the French Government has always taken a keen interest in the question of protection against lightning, that in France the public buildings are admirably protected, whilst in England the first and the last time of Parliament granting money for lightning conductors was when asked for a grant to protect the house in which it meets. The next chapter deals with the best material for conductors, comparing the results of various authorities. This is followed by an exhaustive description of the method employed in protecting the Hôtel de Ville at Brussels, and the Westminster Palace at London. As an example of our author's knowledge and grasp of the subject, we may extract his account of Snow Harris's work at Westminster. He says:—

"Sir William Snow Harris, in his arrangements for the protection of the Palace of Westminster from lightning, has endeavoured to perfect the general conductivity of the whole mass of the building, and so make it assume the same relation to the electric discharge as if it were a complete mass of metal. Westminster Palace differs in one important respect from the Brussels Hôtel de Ville—the general level of the roofs is covered with iron coated with zinc, and in many places directly connected with the earth by cast-iron water-pipes. The roofing thus constitutes, although imperfectly, and only to a limited extent, a protection of itself. Sir William Snow Harris had, therefore, chiefly to provide for those portions of the building which are above the general level of the roofs, and, by the use of ample conductors of copper, to make up for the comparatively low conductivity of the roofing and the iron pipes which connect it with the earth.

"From the terminal which forms the highest point of the large central tower is brought a copper tube of two inches diameter and one-eighth of an inch in thickness, the joints of which are secured by solid screw-plugs and coupling-pieces. This tube is carried down in the south-west angle of the tower and fastened to the masonry by metallic staples. At the junction of the tower with the roofs the tubing is, or at any rate was, thoroughly connected with the metal of the roof, and then continued to the earth in as straight a course as practicable, and there terminates in two projecting branches made of solid copper rod. By carrying this copper tubing direct to the earth, instead of terminating it in the metal work of the roof, the electrical discharge obtains a conducting medium of the same power throughout, in place of having to leave a high power for one of lower conductivity.

"The Victoria and Clock Towers, which are each 300 feet high, are both fitted with a copper band, five inches wide and a quarter of an inch thick. These run down the walls, and are connected with the metal of the roof, and also with the metallic rail of the staircase within each tower. The ornamental turrets and pinnacles of St. Stephen's Porch are protected by small bands of sheet-copper, two inches wide and one-eighth of an inch thick; these are also placed in connection with the metal of the roof.

"The north and south towers of the central block, and the north and south wing towers of the front facing the Thames, have attached to them bands of sheet-copper running from their respective vanes to the roofing below. The bands are connected with the metal of the roof, and are then carried down independently to the earth, in a similar manner to that adopted on the large central tower.

"The only other prominent portion of the edifice is the ventilating shaft of the House of Commons, where, during the sitting of Parliament, a coke-fire is generally burning, and from which, therefore, a stream of warm and rarefied air is constantly being emitted. The conductivity of an ascending column of warm vapour is known to be great, and accidents from this cause are of frequent occurrence, although very often they are not ascribed to their true source. To obviate this danger, the ventilating shaft is provided with a copper tube conductor, fixed on its eastern side, and connected with the metal of the roof.

"This short description of the measures adopted by Sir William Snow Harris for the protection of Westminster Palace contains all the salient points of the system which at that time, some twenty years ago, was doubtless the best that could be devised. But, although nearly £4,000 was spent upon this work, from that time to this, as far as can be ascertained, these lightning conductors have never been tested! It is, therefere, very possible, and indeed probable, that on the occurence of any very heavy thunderstorm they would be found wanting, and considerable damage would ensue, the extent of which no one can estimate."

(TO BE CONTINUED.)

NEW PATENTS, 1880.

5. MAGNETIC APPLIANCES, *F. Bapty.—Jan.* 1.
33. IMPROVEMENTS IN APPARATUS FOR DEVELOPING ELECTRIC CURRENTS AND REGULATING THE ACTION OF THE SAME IN CURRENTS THAT PASS TO ELECTRIC LIGHTS, OR ELECTRO-MAGNETIC ENGINES, *T. A. Edison.—Jan.* 3.
75. IMPROVEMENTS IN DIVIDING AND IN APPARATUS FOR THE REGULATING OF THE ELECTRIC LIGHT, *A. M. Clark* (COMMUNICATED BY *T. Rognier*).—*Jan.* 7.
79. IMPROVEMENTS FOR PRODUCING AND UTILISING ELECTRIC CURRENTS AND IN LAMPS TO BE EMPLOYED IN CONNECTION WITH THE SAME OR SIMILAR APPARATUS, *R. Werdermann.—Jan.* 8.
91. MICROPHONIC AND TELEPHONIC APPARATUS, *W. R. Lake* (COMMUNICATED BY *E. Berliner*).—*Jan.* 8.

ABSTRACT OF PATENTS.

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TRADE SCHOOLS.

Such of our readers as take an interest in the subject of technical instruction for the working classes would gather from Prof. Perry's letter published in our issue of the 3rd inst. that there is some difference of opinion among the Instructors themselves as to the best mode of carrying on their operations. What that difference precisely is or what is its extent we cannot quite make out; but it would seem that it turns upon the different degree of enthusiasm with which each respectively advocate the claims of theory and practice. Both alike are desirable, but both are not equally desired. We are far from implying that the friends of theory are unmindful of practice; on the contrary they would urge with reason that improvement in practice is the ultimate aim of all theoretical teaching. But it appears certain that their critics think this ultimate aim is not quite so closely allied to the immediate means as it ought to be. Practice and theory according to them should go together,—not the practice merely of the class room, but that of the actual workshop.

We think we are right in ranking Prof. Perry on the side of those who emphasise this latter view of the question. He says that "A trade can only be learnt in a real workshop where there are many men as well as the apprentices;" and farther on he relates his experience when a master at Clifton College where he established a workshop with a competent foreman for the benefit of the scholars, and owns that the results were not very encouraging. Although the boys had "two or three hours a day to devote to their work, their manual dexterity at the end of three years was far inferior to that of the youngest apprentice in a real workshop at the end of a year."

That workshops should be attached to "classes in Natural Philosophy" Prof. Perry has no doubt whatever; but he is careful to point out that such so called workhops, although indispensable for "giving students an intimate acquaintance with the properties of materials" are not in any strict sense workshops at all, and can only be regarded as a quite preliminary stage in the process of training. Arguing in this direction the writer advocates the formation of technical schools conveniently situated for the use of apprentices who shall attend them in their working hours, the instruction afforded them supplementing, not preceding, much less superseding, its practical application in the workshop.

It would be ungenerous to place the schemes which have already been set on foot in antagonism or even in contrast with the proposal sketched out by Prof. Perry. No doubt The City Guilds and other societies have done what they could; and it is not unlikely that the writer we have quoted is ignorant of the difficulties which may have stood in the way of carrying out ideas that on the face of them commend themselves to one's practical common sense. But so far as they have gone, the methods now being pursued are not at all such as he can logically approve of. They may be merely tentative, experimental; they may be intended for a different class of persons; or they may be designed to force the hands of employers and Trades Guilds generally to adopt some more direct means of obtaining what is needed. At present however, they are not special classes for special trades, but general classes for all who care to attend. Now we know what this usually means. Indeed the teachers themselves are the first to admit and deplore it. Not workmen attend to get special knowledge of their callings; but students who are in search of knowledge generally,—or, what is as often the impelling motive, in search of Examination Certificates. This is not what the promoters aim at; and we can only hope that a fair trial of the several methods adopted or advocated will speedily disclose one that will best meet the ascertained requirements.

Meanwhile a few observations upon the broad aspect of the question may not be out of place. This agitation for technical instruction has been greatly intensified of late by depression of trade, attributed, rightly or wrongly, in great measure to the ignorance of our artisans—ignorance of the properties and capabilities of the materials upon which they are working. Some writers go farther than this and accuse foremen and workmen alike of indifference to the training of apprentices, amounting to studied concealment from them of the secrets of their handicraft. This strikes us as strange; for although we can well understand the consternation of a workshop upon the advent of a learned apprentice fresh from his "science

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college" and prepared to set everybody to rights with his "first class certificate," we cannot quite believe that foremen will withhold instruction the giving of which would lighten their task of supervision. To bring our illustration hom eto many of our readers, it is conceivable that a superior telegraph clerk might be slow to communicate, and discountenance if already obtained elsewhere, such information as would tempt the novice to experimentalise upon delicate or complicated apparatus; but we cannot imagine him neglecting to teach the method, say, of "firm" working and also the *reasons* for it when the occasion arise. We may further think it questionable whether the workman is entirely or even greatly to blame. It has really yet to be proved that he is more ignorant than the workman of other countries which are supposed to be beating us because of their superior technical instruction. All the direct evidence points rather to the masters being at fault and not the men. We cannot speak positively as regards other countries; but it is certainly the case in this, that in large numbers of instances the masters themselves are not by any means experts—except indeed in the art of making money. Captains of Industry have given way to Privates with Capital, whose business it is to create fortunes, not to learn trades. Now if the effect of the movement we are discussing should happily teach these persons that Fortune is not for long to be bought at a price, but must be wooed in the paths of Knowledge, no greater boon could be at present conferred on English Industry. We quite recently heard a most admirable speech delivered on this subject by one who holds a very high position in the world of applied science. He said "I wore my leather apron, served my apprenticeship, and worked as hard as any of the men in my father's shop; and this, coupled with the scientific training I had previously and still received, has enabled me to rise to my present position." This is precisely what we might expect; and it is what we should suppose everybody desires may continue. Unfortunately, however, these remarks were addressed not to masters, or sons of masters, like himself; but to workmen; and what we say is that the master needs this lesson quite as much as the man. Primarily he needs it a great deal more, for it is the head of an establishment who must initiate all improvement, and it is from him that all encouragement must come for the acquisition of technical knowledge by his servants.

We are not here depreciating the value of technical attainments among workpeople; and there is of course no objection to encouraging it by legitimate hopes of reward. But as this reward rests ultimately with the masters, anything fostering the notion that scientific teaching will enable any man to rise to the "position" of master, is calculated to rouse their hostility rather than enlist their sympathy. It is this, we suspect, which has delayed the much talked of and long promised instruction in electrical science which every telegraph clerk was to have received in the Postal Telegraph service of this country—an apprehension that increased attainments would lead to increased claims for remuneration. In the industrial world generally there should be no grounds for such apprehension, the workmen finding their reward in greater prosperity of trade, permanency of employment, and, for the exceptionally qualified, a certainty of promotion. All men are not so qualified, and very few indeed are capable of achieving the position of him from whose speech we have just quoted, or sustaining such a position even if it were conferred upon them. Nature has not yet become a convert to the doctrine of equality. Until she does, we must accept the facts as we find them, beginning at the top if we may, or at the bottom if we must; but in any case starting with well-defined and not over ambitious aims.

As to these aims there would be no doubt about the mode of procedure were Masters, Superintendents, or Foremen, alone the object of our attentions. But as concerns workmen—actual or intending—the method is not so clear simply because our conception of the object to be served and the limits of instruction is not yet quite clear to ourselves. Probably this circumstance has led to the outcry against a project, originating we believe with South Kensington, for purchasing the costly and luxurious West End mansion of a certain disestablished baron of financial renown, as a great central technical college. The shaping of means to ends is not quite apparent to the public mind in this contemplated purchase, and the large sum of money to be spent upon it. If we want to succeed, a common worldly maxim tells us we ought first to know exactly what we want to succeed in. It does not stipulate however that we should tell everybody what we want; and perhaps, after all, the promoters of this big scheme are only preserving a discreet silence as to that. Perhaps, all the while, they desire to provide comfortable quarters, together with the highest possible instruction for the only people who are sure to be able to turn it to profitable account;—a quite unexceptionable enterprise, so long as the people in question are made to pay for it. But to elaborate such preparations, on such a scale, and in such a quarter, for teaching trade secrets to the lower classes, is, to our thinking, like establishing a swimming Seminary on Salisbury Plain.

On the whole, we watch this movement with solicitude not unmixed with anxiety; hoping that out of the conflict of counsel some good may come, and that finally, notwithstanding a few errors at the outset, a sound system of technical instruction may be established for master and man alike, but adapted specially to their respective needs and capacity.

CORRESPONDENCE.

MAGNETIC APPLIANCES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I thank you for your courtesy in replying to my letter, but you will pardon me for saying that your explanation is a little too scientific for my non-scientific education. What I wish to know is:—(1st) Do magnetic appliances when worn upon the body produce electric currents as stated in advertisements? (2nd) Have they any curative efficacy, or (3) any analogy to Pulvermacher's appliances?—Yours, &c., A. J. LEWIS.

102A, Mount-street, Grosvenor-square, W.,
14th January, 1880.

[Our answers to your questions are:—1, No. 2, In our opinion, they have no such efficacy, or, at least, none due to their *magnetism*. 3, No.—[ED. *E.*]

"PROSPECTING" METAL VEINS BY THE INDUCTION BALANCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The note in a recent issue reporting the invention of a method for detecting and tracing veins and lodes of metals in the earth by means of electricity has suggested to me the application of the induction balance of Professor Hughes to this purpose. It is well known that the balance is extremely sensitive to the neighbourhood of metals, and it becomes a question worth settling by experiment whether this sensibility could not be employed as a means of indicating the presence of metalliferous ores underground. The obvious mode of applying the apparatus would be to separate the two induction pans of the balance to such a distance apart that, while one of them was brought under the influence of the concealed metal, the other would be comparatively unaffected. This could be done, perhaps, by elevating the balance vertically on a pole or standard, to be carried about by the prospector, so that one pan was brought

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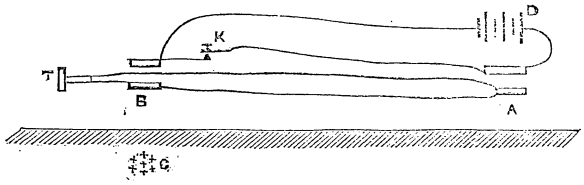
near the surface of the ground, while the other was raised above it to a considerable height, say, of ten or twelve feet. On a balance being obtained in a proper locality the search could begin, and the presence of veins under foot might be found to reveal itself by disturbing the balance. A better but more inconvenient plan, from its rendering it necessary to pay out a portable line or wire, would be to keep one pan of the balance stationary in one place, while the other was being moved about so as to feel for the hidden ores. The latter method is shown in the accompanying sketch, where A is the stationary pan of the balance, and B is the movable pan carried by the prospector; c is a metal lode under the surface, D is the battery, and K is the key in the primary circuit of the balance, and T is the telephone in the secondary circuit. While moving over the ground the prospector makes and breaks the primary circuit by means of the key, and listens in the telephone for any sound indicating that the equilibrium of the induced currents has been disturbed.



Should the balance prove sufficiently sensitive, it can, of course, be used for similar and allied purposes in mining and boring operations, so as to trace the positions and roughly determine the richness of metal veins, ores, and other conducting minerals such as coal, graphite, &c. The first plan would probably answer best in cases where the metal was at or near the surface, as is the case in "surface diggings."—Yours, &c., J. M.

CONTRIBUTIONS TO A PHYSICAL THEORY OF ELECTRICITY.

BY DESMOND G. FITZGERALD.

(CONTINUED FROM P. 83.)

III.

Some Applications of Dynamical Principles.

Owing to the interest with which, in some directions, certain *formulæ* relating to resisted motion have been received, and to a desire which has been expressed that some applications of them should be given, I am led to extend somewhat the dynamical considerations which were incidentally entered upon. Perhaps I cannot better employ the space at my disposal than by attempting clearly to point out the direction in which the *intuitive* dynamical principle that, when men or machines exert force to do work, *time varies inversely as power when space is constant* is sometimes at fault, and also the grounds for the popular instinct which confounds "power" and "force," and, whilst correctly measuring work by *power into time* (fs), regards this as being, in practical application, equivalent to *force into time* (ft). At the same time some problems may be given illustrating the application of the formulæ above referred to.

Let us in the first place take as an instance the following apparently very simple question:—If a man—say by means of a windlass—can raise a given mass to the height (h) in 10 seconds, in what time could 10 men raise it to the same height?"

In at least nineteen cases out of twenty, the practical man who well knows what mechanical work means will unhesitatingly reply:—"In 1 second." In the twentieth case, perhaps, an answer will be given, not without some hesitation and some calculation, which amounts to this:—that $t = \sqrt{\frac{2ms}{f - mg}}$. The answers are not identical; yet both, in a sense, may be perfectly correct; because the question is equivocal.

(a) The question may mean, and to the practical man doubtless would mean:—If one man can do work sufficient to raise a given mass to the height h in 10 seconds, in what time can ten men, each equal in strength to the first man, do work sufficient to raise the same mass to the same height? In this case—and the practical man requires no theory to guide him to this result—1 *second* is the correct answer; albeit it indicates that the work here varies as ft. For, the *power* of the ten men being ten times that of the one man, we have:—

$$10\frac{W}{t} = \frac{W}{t_1}; \quad \text{whence } t_1 = t\frac{W}{10W};$$

or, since the work is in both cases the same, $t_1 = \frac{t}{10}$.

Further, we may write the above equation

$$t_1 = t\frac{fs}{10fs};$$

and, cancelling out the s,

$$t_1 = t\frac{f}{10f}; \quad \text{whence } 10ft_1 = ft.$$

Or, work being constant, *time* here varies inversely as *force*.

(b) But the question may mean, and, strictly speaking, does mean:—If a given mass reach the height h in 10 seconds when work is done upon it (against $\phi = mg$) by one man, in what time will it reach the same height when work is done upon it by 10 men, each equal in power $\left(\frac{W}{t}\right)$ to the first man? In this case the correct answer cannot be one second; since, to reach the height h in $\frac{1}{10}$th of the given time, the mass must move with a tenfold mean velocity; the mean velocity being then represented, say, by 50, and $s = \frac{v}{2}t$ being also 50; whereas, when time is 10 sec., the final velocity is represented by 10, the mean velocity by 5, and $s = \frac{v}{2}t$ by 50. Thus, when $t = 10$, the total work done would be represented by $mgh + m\frac{v^2}{2} = mgh + m \times 50$; and, when $t = 1$, it would be $mgh + m \times 5000$. The latter value is necessarily greater, and may be very much greater, than the former. But the work done by the ten men in 1 sec. should be exactly equal to that done by the one man in 10 sec.; or $10\frac{W}{1} = \frac{W}{10}$. Therefore the velocity obtained in the second instance cannot be ten times that obtained when $t = 10$ sec.; and the time in the second instance cannot be only $\frac{1}{10}$th of the given time. In order to produce the velocity 100 in 1 second, the ten men would have to exert an accelerating force 100 times greater than that exerted by the one man during 10 seconds to produce a final velocity of 10.

It will be seen that the original question is so worded as to allow of the *time during which the force acts* being confounded with the *time in which the mass moves through the space h*. In the statement (b) of the question, the required time is *the time during which the force is applied* $\times \frac{f}{\phi}$ (see p. 52, 2nd paragraph).

Before considering some problems more definitely expressed than the above question, let us put our equations (VI.) and (VII.), for s and t, into the form that will be most convenient. Since $s = \frac{v}{2}t$, and $v = at = \frac{f_1}{m}t$, we have—

$$s = \frac{at^2}{2} = \frac{f_1 t^2}{2m}; \quad \ldots\ldots\ldots \quad \text{(VI}a\text{.)}$$

whence

$$t = \sqrt{\frac{2s}{a}} = \sqrt{\frac{2ms}{f_1}}; \quad \ldots \quad \text{(VII}a\text{.)}$$

a being accelerate, and $f_1 = am$ being accelerating force [formulæ (Va.) and (IX.)].

Problem 1. A constant force (f), equal to the weight of 58lb. ($g = 32{\cdot}2$) is applied to raise a mass (m) of 56lb. In what time (t) will the mass reach the height of 180 ft. (s), and what will be the kinetic energy stored up in it at the end of this time?

By (VIIa.) $t = \sqrt{\frac{2s}{a}}$.

By (XII.) $a = \frac{f_1}{m}$.

By (X.) $f_1 = 58g - 56g = 2g = 64{\cdot}4$ abs. units of accelerating force.

Therefore $a = \frac{64{\cdot}4}{m} = 1{\cdot}15$,

and $t = \sqrt{\frac{180 \times 2}{1{\cdot}15}} = \sqrt{313} = 17{\cdot}69$ secs. (Ans. 1.)

The kinetic energy, in absolute units of work will be

$$m\frac{v^2}{2}.$$

By (IX.) $v = at = 20{\cdot}34$ ft. per sec.,

$$v^2 = 413{\cdot}84, \text{ and } \frac{v^2}{2} = 206{\cdot}92;$$

therefore $m\frac{v^2}{2} = 56 \times 206{\cdot}92 = 11587$ abs. units of energy. (Ans. 2.)

N.B.—The student should verify the fact that here

$$\phi s + m\frac{v^2}{2} = mgs + m\frac{v^2}{2} = fs = \phi S = 336168 \text{ abs. units of work.}$$

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PROBLEM 2. A constant force equal to 10 times the above, viz., to the weight of 580 lb. is applied to raise an equal mass, viz., 56 lb. In what time will the mass now reach the height of 180 ft., and what will be the kinetic energy stored up in it at the end of that time?

$$f_1 = 580\,g - 56\,g = 524\,g = 16873.$$

$$a = \frac{f_1}{m} = \frac{16873}{56} = 301{\cdot}3 \text{ ft. per sec.}$$

$$t = \sqrt{\frac{180 \times 2}{301{\cdot}3}} = 1{\cdot}093 \text{ sec.} \qquad \text{(Ans. 1.)}$$

$$v = a\,t = 329{\cdot}35 \text{ ft. per sec.,}$$

and

$$m\frac{v^2}{2} = 3{,}037{,}100 \text{ abs. units of energy.} \qquad \text{(Ans. 2.)}$$

In foot-pounds this energy would be

$$\frac{3037100}{32{\cdot}2} = 94351.$$

This divided by mass gives the height $(S - s)$ to which the mass will be carried by the kinetic energy stored up in it

$$S - s = \frac{94351}{56} = 1684 \text{ feet (nearly).}$$

The total height to which the mass will rise, if the force (f) be removed when m has reached the height of 180 ft., is thus

$$S = 1684 + 180 = 1864 \text{ ft.}$$

The energy of position in the mass when it has reached this total height will be, in foot-pounds,

$$m\,S = 104384 \text{ (nearly).}$$

and in abs. units, $m\,g\,S = \phi\,s = 3361680$.

PROBLEM 3. What mean or constant force would be required to raise the mass of 56 lb. to the height of 180 ft. in $\frac{1}{10}$th of the time to which it can be raised to the same height by a force (Prob. 1) equal to the weight of 58 lb.?

Here the given time is 1·769 second, $m = 56$, and $s = 180$.

By (VII*a*.) $t = \sqrt{\frac{2\,m\,s}{f_1}}$, $\sqrt{f_1} = \frac{\sqrt{2\,m\,s}}{t}$, and

$$f_1 = \frac{2\,m\,s}{t^2} = \frac{20160}{3{\cdot}129} = 6446.$$

By (X.) $f = f_1 + \phi = 6446 + (56 \times 32{\cdot}2) = 8249$ abs. units of force. (Ans.)

Or, expressed by the mass of which the weight would equal this value

$$f = \frac{8249}{32{\cdot}2} = 256 \text{ lb.}$$

Thus the accelerating force necessary to move a given mass through a given space varies inversely as the square of the time during which the force is applied.

PROBLEM 4. In what time (t_1) will the total work done on the mass (m) be converted into energy of position, or in what time will m move through the space S, in Prob. 1? Also in Prob. 2?

In the first case the initial velocity is 20·34 ft. per sec. obtained at the end of 17·69 sec. (t).

The mass will move over the space $S - s$ in the time $(t_1 - t)$ it would take to obtain this velocity under the influence of gravity. Thus

$$t_1 - t = \frac{v}{g} = \frac{20{\cdot}34}{32{\cdot}2} = {\cdot}63 \text{ second,}$$

and

$$t_1 = 17{\cdot}69 + {\cdot}63 = 18{\cdot}32 \text{ sec.} \qquad \text{(Ans. 1.)}$$

In the second case

$$t_1 - t = \frac{329{\cdot}35}{32{\cdot}2} = 10{\cdot}22.$$

$$\text{and } t_1 = 1{\cdot}09 + 10{\cdot}22 = 11{\cdot}31. \qquad \text{(Ans. 2.)}$$

By the statement at p. 52

$$t_1 = t\,\frac{f}{\phi}.$$

According to this, in the first case,

$$t_1 = 17{\cdot}69 \times \frac{58}{56} = 18{\cdot}32.$$

And in the second case

$$t_1 = 1{\cdot}093 \times \frac{580}{56} = 11{\cdot}32.$$

(TO BE CONTINUED.)

THE TELEGRAPHS OF THE GERMAN EMPIRE FROM 1876 to 1879.*

The Administration of Posts and Telegraphs of the German Empire has just published a report on the results obtained in these two branches from the year 1876 to the beginning of 1879. This document is deserving of particular attention; for it was at the beginning of 1876 that the fusion of the two services was effected in earnest; and we know that—without mentioning the results obtained in the postal service, with which we have here nothing to do—this fusion inaugurated for the German telegraphs a period of activity and transformation which is most remarkable. Thus, from the technical point of view, it was the inauguration of a system of underground lines, extending over long distances, in substitution for overhead wires; and, from the administrative point of view, it was the introduction of the word tariff in lieu of the old method of charging per telegram of 20 words.

These two great reforms, with which were combined a number of improvements more limited in scope, give a special interest to the history of the three years included within the report; since we do not find an equivalent progress in the service of other European Administrations, and it is in Germany alone that we can at the present moment find, on the one hand, long stretches of underground line, and, on the other, a taxation per word in every direct relation.

We should observe, before commencing our extracts, that the data do not include the services of Bavaria and Wertemberg, but only the service of the Administration of the Empire properly speaking, of which the control extends to a territory of 444,441·76 square kilometres (excluding 4,343·81 sq. kilom. of water surface) and to a population which, according to the re-census of 1875, amounts to 35,851,475 inhabitants.

I. NETWORK OF LINES. *(Réseau).*

For its communications, the Administration employs conjointly three different systems, viz: aërial lines, underground lines, and pneumatic tubes. Under these heads, the following are the results given in the statement made by the Administration:—

AËRIAL LINES.

The length of the overhead lines was, at the close of 1875,	35,708·41 kil.
And, at the close of March, 1879,	48,189·37 „
During the 3¼ years there have consequently been erected	12,480·96 „

showing an increase of about 35 per cent.

At the end of 1875, the length of conducting wire was	132,009·69 kil.,
And, at the close of March, 1879,	163,887·09 „
Showing an increase of	31,877·40,

or an augmentation of about 24 per cent. as compared with 1875.

This considerable increase in the telegraphic network extends to all points in the territory of the Empire, but more particularly to those portions of the country which, by reason of the less advanced development of their traffic, had remained completely outside of the telegraphic communications. Amongst the mountainous districts thus brought into the network should be specially mentioned:—The Riesengebirge, the Erzgebirge, the Rhœn, the Harz, the Sauerland, the Westerwald, the Hundsrück, the Eifel, the Odenwald, and the Vosges. At the same time the telegraphic communications have been considerably increased in all the borders of the Empire.

The extension of the lines and the increase in the number of conducting wires have necessitated the use of

200,000 posts,
500,000 insulators,
500,000 supports for ditto,

and 3½ millions kilograms of iron wire.

The greater portion of this material was derived from the country itself, to the benefit of forest culture and national manufactures, and the construction of the lines supplied productive labour to a large number of working men.

The impregnation of the telegraph posts with sulphate of copper was for the most part effected by agents of the Administration in timber-yards belonging to the Empire. The number of these yards in activity was

15 in 1876
19 „ 1877
and 17 „ 1878.

It is from March to November in each year that this impregnation with sulphate of copper is effected, under the superin-

* Translated from the *Journal Télégraphique*.

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tendence of telegraph functionaries. The number of posts impregnated was—

In 1876	87,988	representing	20,666 cubic metres
In 1877	119,045	,,	24,456 ,,
In 1878	114,522	,,	24,034 ,,

The cost of the prepared wood, per cubic metre, was—

32·23 marks, in 1876,
30·74 ,, 1877,
28·95 ,, 1878;

which, for an average post of 8·5m. represents, in the respective cases:—8·10, 7·49, and 7·04 marks.

The preparation of the posts in the yards belonging to the empire has therefore not only been attended with a favourable financial result, but has in a greater measure rendered the Administration independent of contractors. Besides it allowed of the interests of sylviculture being taken into account, in the sense that the yards could often be established in certain localities in accordance with the wishes of the governments.

Coming under the head of extraordinary credits allowed for the extension of telegraphs by the Federal Council and the Reichtag, the sum of 6,793,435 marks was expended.

The expenses of maintenance and alterations of certain portions of the overhead system amounted to—

a. In 1876, and in the first quarter of 1877, to 1,734,124 marks
b. For work carried out in 1877-1878, to 1,702,972 ,,
c. ditto, in 1878-1879, to 1,510,219 ,,

As, in certain sections of line, the posts were overweighted with wire, it was requisite, to a greater extent than previously, to erect twin posts or a double row of posts. Thus, these twin or double posts which, at the end of 1875, extended over 1,493 kilometres, extended at the end of 1878-79 over 1,978 kilom. The Administration is continuing the work of relieving the single posts by establishing twin posts or double rows of posts.

Underground Lines.

The introduction of a system of underground wires should be pointed out as being an important progress in telegraphy. Its advantages for short distances were appreciated; but, in the case of long distances, the unsuccessful attempts made a quarter of a century previously had left room for much doubt, uncertainty, and apprehension, which an experiment upon a large scale could alone remove. It was only after a careful study of all the questions involved that the Administration, at the close of 1875, was led to formulate a vast project for the establishment in the empire of an underground telegraphic network. Having obtained the necessary credits for the carrying out of its programme, the Administration inaugurated it, in the summer of 1876, by the construction of the trial line from Berlin to Halle, in which it profited by all the resources offered by telegraphic science and practice. The brilliant results of this experiment led it to immediately undertake the execution of the general plan. Amongst the lines which this plan indicated as collectively assuring telegraphic communication between the most important commercial towns, as well as with the fortresses and ports of the empire, the following were constructed during the years 1876, 1877, and 1878:—

a. Berlin, Halle-sur-Saale, Francfort s/M., Mayence;
b. Halle-sur-Saale, Leipsig;
c. Berlin, Hambourg;
d. Hambourg, Kiel;
e. Berlin, Magdebourg, Brunswick, Hanover, Minden, Münster, Wesel, Düsseldorff, and Cologne;
f. Cologne, Elberfeld, Barmen;
g. Francfort s/M., Darmstadt, Mannheim, Carlsruhe, Rastatt, Kehl, and Strasbourg;
h. Hambourg, Cuxhaven.

Moreover, in conjunction with the Danish telegraph administration, a submarine cable was laid between the islands of Alten and Fionia. As to the laying of the cable across the North Sea, from the island of Silt to Arendal, with a view to the establishment of direct communication between Germany and Norway, this was completed in the course of the summer of 1879.

The underground system of the German empire has at the present moment an extent of 2,487 kilometres of lines, having in most cases 7 and in other cases 4 conductors; giving a total of 16,740 kilom. of underground wire. The longest line, that from Kiel to Strasbourg, is over 1,219 kilometres in length.

These figures do not include the enclosed wires which had previously been laid in towns, tunnels, rivers, lakes and arms of the sea; these being comprised with the overhead lines.

The main difficulties in establishing the subterranean lines were presented by marshy and rocky soil, the streets of large towns, the works and fortifications of fortresses, and in the passage of rivers. River cable of special construction, to the extent of 3,642 metres, was employed, in 30 sections, for the passage of the Elbe, the Havel, the Dosse, the Rhine, the Lippe, the Emscher, the Ruhr, the Neckar, the Murg and the Kinzig, as well as smaller watercourses and navigable canals.

The following lines—

a. Hambourg, Bremen, Emden, with branches to Bremerhaven and Wilhelmshaven;
b. Cologne, Coblence; Mayence, Coblence; and Coblence Trèves, Metz;
c. Metz, Strasbourg;
d. Berlin, Dresden,

are in course of construction, and will be completed this year (1879).

Preparations are being made for the carrying out of the following lines in 1880:—

a. Berlin, Francfort s/O, Breslau;
b. Berlin, Müncheberg (section of the future line from Berlin to Küstrin, Posen, Thorn);
c. Berlin, Stettin.

When these lines have been established, the construction of the Stettin, Colberg, Danzig, Kœnisberg line, and of the Müncheberg, Küstrin, Posen, Thorn line, as well as of that between Cologne and Aix-la-Chapelle, will be proceeded with. It is also proposed to extend the Kœnigsberg line to the Russian frontier, near Eydtkuhnen, and the Breslau line to the Austrian frontier, near Orderberg.

The completion of these works, which is fixed for the year 1883, will have realised in its essential parts the general plan of the creation of an underground network of lines extending through the great commercial and military highways of the empire.

In this progressive path Germany has taken the lead of all the other nations, and by the establishment of its underground system, already very extensive, it will be considerably in advance of all the other European States. The sums expended up to the present time in order to obtain this result, and furnished by the extraordinary credits granted by the Federal Council and the Reichstag, amount to 12,721,821 marks. This expenditure has given a fresh impulse to some very important branches of national industry.

The great value of underground telegraph lines in relation to the security of communications, and to those important interests of populations and States which are dependent upon such security, no longer requires to be demonstrated. The serious damage which even last winter occurred to the overhead telegraph lines of various States, in consequence of violent tempests and snowstorms, damage which resulted in long interruptions of the telegraphic service, and in consequent injury to commerce, navigation and public as well as private interests, constitute a more than sufficient reason to urge forward energetically the execution of the underground network of telegraphic lines.

The construction of the cables and the means adopted for laying them have hitherto met all the requirements; but this favourable result evidently need not prevent the due consideration of all the improvements suggested by fresh scientific observations. Of the latter it may be said merely that it is desirable their number should bear some relation to their practical utility.

(TO BE CONTINUED.)

A NEW LIGHTNING PROTECTOR.*

BY JOHN FAUSTBÖCK

(Manager of the Telegraph Station in Hartberg).

This protector (Figs. 1 to 3) is intended for intermediate telegraph stations. The two ends of the line entering the station led to two brass bars d_1 and d_2 (Fig. 2), bent at right angles, and let into a thick base board G. Into the ends e_1 and e_2 of these bars are screwed two points g_1 and g_2, and opposite to these and at a short distance from them are two other points g_3 and g_4, similarly screwed to bars, also attached to the base-board G. A metallic base-plate equal in thickness to the bars is also shown in Fig. 2. Fixed to G are also the two bars a_1 and a_2, between which is inserted the telegraph apparatus of the station. Over a_1 and a_2 is a wooden rod q (Fig. 1), and on this is fixed the brass bar j, with terminals i_1 and i_2. Thick copper wires h_1 and h_2 pass to f_1 and f_2; and from f_1 a thick copper wire r is conducted to the earthplate E. The two points g_3 and g_4 are therefore in constant contact with earth, and hence the atmospheric electricity passing between the points g_1 and g_2, and g_3 and g_4, is by these means discharged to earth.

On the lower side of a thick wooden disc are further screwed two brass plates b_1 and b_2, in the form of a crescent (Fig. 3), and the space between these, 1 cm. in width, is filled up by two ivory

* From *Zingler's Polytechnichem Journal*, vol. 232, p. 131.

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plates, p_1 and p_2, not quite in contact with each other. On the upper side of the disc the handle C is screwed, this being, as in Fig. 1, to a great extent covered over by the thin wooden plate H. Through H and C and into the thick wooden disc passes a brass rod, of which the knob X projects, and which serves as a pivot. Over H extends the arch B, which is fastened on to a square block D, which is screwed on to the thick base plate G; a knob at the centre of this arch holds the nut for the screw O, by means of which X with H and the underlaying thick wooden disc, filling the cylindrical hollow in D, can be screwed down in such manner that the brass segments b_1 and b_2 are firmly pressed on the brass springs s_1 and s_2, s_3 and s_4, screwed on to the bars d_1 and d_2, a_1 and a_2. These parts are held in position by the counter nut U.

If the handle C is pressed firmly on to the contact N, b_1 produces the conducting connection between d_1 and a_1 b_2 between d_2 and a_2, and the station apparatus is inserted in the line. If, however, the handle C is firmly brought into contact with the arch B, b_1 becomes connected with d_1 and d_2, b_2 with a_1 and a_2; therefore, the apparatus becomes quite disconnected from the line, the two ends of the line (land), however, closely connected together by b_1, and still can the atmospheric electricity discharge itself from g_1 and g_2 to earth E.

FIG. 1

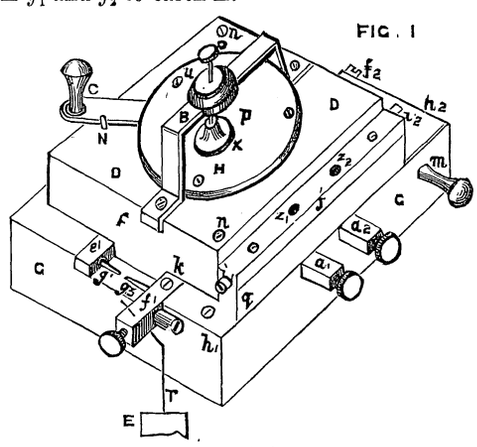


FIG. 2.

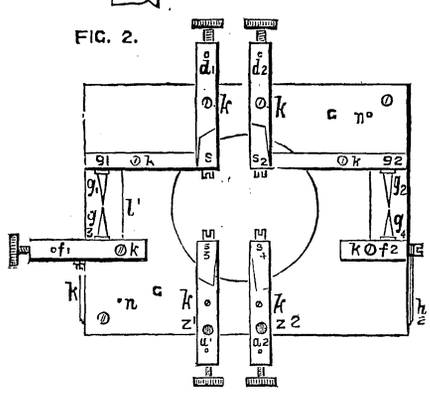
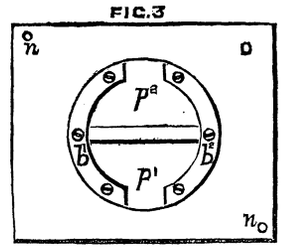


FIG. 3



Finally, for example, when line disturbances occur, to be able to conduct to earth the first as well as the second section of line and, at the same time, to utilise the station apparatus in end station arrangement in the other section, the bars j, a_1, and a_2, which cross each other, are provided on their crossing points (places) with holes z_1 and z_2, into which can be put the brass plug m, furnished with an ivory knob, and thus connects either a_1 or a_2 with j, d, h, and the earth conductor. This plug is split on both ends, and is usually kept in a hole of the base-board G.

Besides the protection of the apparatus during a thunderstorm, this lightning protector, which has proved quite efficient on trial during thunderstorms in Hartberg (Styria), admits of a constant and quite convenient supervision of the opposite position of the opposed points conducting the atmospheric electricity.

It is true that lightning protectors, having plates with cross grooves, there exist more transition points; however, with these, conducting connections of the plates can very easily arise, either by lightning or other causes, and these are less easily and conveniently to be observed and removed. As, further, the points g_1 to g_4 lie quite free, and are enclosed in a smaller space, they cannot, therefore, when strong atmospheric discharges take place, heat excessively the surrounding atmosphere, and by its rapid expansion cause damage. Finally, the points can be, if necessary, easily and conveniently exchanged.

When exchanging one of the four points, the earth-constructing wire r is first to be taken out from the bar, and then the screw i_1 or i_2 is to be loosened, so as to liberate the wire h_1 or h_2; if, then, the screw K is also removed, the bar f_1 or f_2 can be easily taken out, whereupon not only the point g_3 or g_4 contained on its ends can be conveniently exchanged, but also that point g_1 or or g_2, lying on the opposite screw e_1 or e_2.

This lightning protector excludes any stoppage of the line, because neither of the two positions of the crank C interrupt the line.

THE ELECTRIC LIGHT IN THE CITY.

The premises of Messrs. Samuel Brothers, merchant tailors, Ludgate Hill, have been fitted up with the electric light, and the inauguration of the lighting took place on Wednesday evening, the 14th inst., in the presence of a large number of gentlemen interested in the question of electric lighting. They are lighted by means of thirteen electric lamps of the Jablochkoff system, and which are distributed as follows :—

One in each of the two windows on each side of the principal entrance in Ludgate Hill	2
Two in the front of the ground floor	2
Two in the back ,,	2
One in the counting house	1
One over the landing of the large staircase leading to the upper floor	1
Three in the juvenile and ladies' department on the first floor	3
Two in the gentlemen's bespoke department on the first floor	2

The lamps are all suspended from the ceiling, at a distance of about 8 feet from the floor, by means of harp pendants, through which the conducting wires are conveyed to the candles. They are made to contain four Jablochkoff candles, each about 9 inches in length, and as each candle lasts two hours, a continuous light for eight hours is provided. The globes are of the opalescent description, and 20 inches in diameter.

The currents of electricity are produced by Gramme's patent dynamo-electric machine of the twenty light size, a small Gramme continuous current machine exciting a large alternating current distributing machine. The large machine is divided into four circuits, capable of maintaining five lights each. In the existing arrangement three circuits only of the distributing machine are utilised, two maintaining four lights each and one maintaining five lights. An additional lamp was temporarily added to that number, and was kept burning in the engine room, which it lighted admirably. The lights are arranged so as to be all switched from a switch board placed at one of the cashier's desks on the ground floor. This arrangement is an important feature, and the switching was shown in operation. By means of the switch an attendant every two hours directs the current into the new candles.

The motive power for working the electric machines is obtained from a 12 horse-power "Otto" gas engine, made by Messrs. Crossley Brothers, of Queen Victoria Street, London. The Gramme machines are driven directly by means of suitable pulleys fixed on the shaft of the engine, the small one, or excitor, running at a speed of 612 revolutions, and the large one, or distrubutor, at a speed of 688 revolutions per minute. They are together with the gas engine erected in a room situated in the basement at the back of the building. The whole mechanical and electrical plant, which have been fixed and fitted up under the immediate supervision of Mr. J. A. Berly, C.E., the engineer to the Société Générale d'Electricité, are erected in a most substantial manner. This is the first time that a large number of Jablochkoff lights have been worked from a gas engine, and Messrs. Samuel Brothers deserve great credit for the enterprising spirit which they have shown in adopting for their establishment this mode of illumination which is now steadily making its way, and will, in all probability, be more widely adopted within a very limited period. The great advantage of the electric light over gas in enabling one to distinguish shades of colour was well seen. Various cloths of various tints, each of which could be readily matched were conspicuously shown for comparison, and we should imagine that this advantage to purchasers is by no means a small one.

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JUVENILE LECTURES AT THE SOCIETY OF ARTS.

The second of two lectures by Mr. W. H. Preece, M.I.C.S., adapted to a juvenile audience, was delivered on the evening of the 9th instant at the Society of Arts, John-street, Adelphi, when a crowded audience again assembled, encouraged by the pleasure derived on the previous occasion, and the same interest was displayed in the simple and lucid, but eminently practical, observations of the lecturer. Suspended against the wall were diagrams representing various dynamo-electric machines, such as Gramme's, continuous and alternate—Lontin's, Simens', Wyld's, De Meritens'; various lamps—Serrin's, Siemens', Rapieff's, Lontin's, &c.; and different candles, including the Jablochkoff, Wylde, Rapieff, De Meritens, &c. Four of the Jablochkoff lamps were lighted in the course of the experiments, the electricity being pumped from the shed underneath the Charing-cross Bridge, the source whence the lamps on the Thames Embankment are supplied. Mr. Preece, at the outset of his lecture—entitled "Recent Wonders of Light"—remarked, as on the previous occasion, that the principal object he had in view was not to startle them with new wonders, but to endeavour to call into action the scientific use of their imaginations. Light, like sound, he then observed, was a mere form of vibration—the vibration of a medium that filled all space, and, like sound, it required some source to set the vibrations in motion. The mode by which a ray of light was transmitted from a spark to the eye was just the same as that by which a clap of the hand was conveyed to the ear, but the velocity of the two was very different. After explaining this and the different qualities of light, illustrating his remarks with numerous experiments, he observed that oil was introduced in the streets of London in 1684, gas in 1813, and electricity in 1879. Just as gas had caused such an improvement in oil lamps and candles, so the electric light would drive gas engineers to produce a better gaslight. Mr. Sugg, indeed, by his London Argand burner, had "taken the wind out of the sails" of some of the electric light people, and shown how London could be most brilliantly lighted. The solution of the best luminant was dependent on our being able to concentrate the greatest heat on the smallest amount of matter. This was best effected by electric currents. There were many ways by which electricity could be produced. The greatest currents were produced by moving coils of wire with the greatest velocity through the strongest magnetic field. Exhibiting a small machine, consisting of a magnet inside of which was a coil of wire, he showed how, by rapidly turning a handle, he produced electricity, and thereby heat. He also showed another mode of producing electricity, by the combustion or burning of zinc, and pointed out how the light intensified as the current passed through the wire. Subsequently he made some experiments with the electric arc, showing how the light he displayed was produced, and pointing out that the arc was maintained because the clock or wheel-work attached maintained the two pieces of carbon (referred to) at a proper distance. The whole difficulty was to maintain the carbons at a proper distance apart to compensate for the rate at which they were unequally burned. He next alluded to several lamps before him, and observed that one of the most ingenious systems was that of Jablochkoff. Having shown how Jablochkoff dispensed with complicated machinery by making use of what was called a "candle," and explained how the pieces of carbon were separated, he pointed out how the candles were arranged in groups of four, and how the whole series were burnt one after the other. This particular candle, he remarked, was really an arc, although to a certain extent it became an incandescent light. He then made a very interesting experiment, a picture being thrown on the screen of the arc itself, and showed how the lamp worked. Reverting to the Jablochkoff candle, he stated that through the kindness of the Society who lighted up the Embankment two wires from their place underneath the Charing-cross Bridge had been brought to that room, and the engine which was pumping electricity at that moment for the Thames Embankment was also pumping up electricity to them. Mr. J. A. Berly, C.E., the engineer to the Société Générale d'Electricité, at the request of Mr. Preece, then threw this current of electricity on to the room, the gaslights having been turned out, producing almost immediately a great change in the temperature. The lecturer continuing, said that they were then in a cold light, one which would not vitiate the atmosphere, one that gave a brilliant light, and one that was destined to produce great wonders. A great deal of nonsense was talked about electricity and gas. They had been startled lately by a telegram from the other side of the Atlantic, but to those who could use the telegram properly nothing but the most outrageous absurdity was announced. A correspondent of one of the newspapers had telegraphed that a lamp of great cheapness had been devised; but the first part of the telegram said that Mr. Edison had produced a light which gave 16 candle-power, and that one horse-power could maintain eight of these lights going. To some that might be a very extraordinary fact, but those who knew something about the consumption of gas and the forms of electricity were aware that in London alone they are producing ten times that amount. Siemens, in his machine, produced ten times the light which was supposed to be produced in New York. But gas did the same thing. The amount of coal consumed in raising one horse-power was 3lb., and this one horse-power was said to maintain eight lights, each giving an illumination of 16 candles, equal altogether to 128; but 3lb. of coal would produce 142 candle-power by gas. Therefore this "wonderful discovery," which sent gas shares down so very much, was actually worse than the gas burned in the streets of London. However, electricity would certainly have its day. It was a brilliantly beautiful light, as they had all seen. Those who went to the British Museum could read and study under a light as soft as daylight. There were halls and buildings where gas was injurious to health, and if an electric light could be supplied which would put an end to such a state of things, a great hygienic improvement would be produced. There was another point connected with light that was interesting—that the motion of coils could be produced by windmills, steam power, waterfalls, &c., so that the great forces of nature could be converted by means of electric currents into sources of light at great distances from the point of origin. In closing his lecture he urged those of his audience who wanted "to know these things" to find out for themselves by experiment and trial, remarking that reading was very soon forgotten. On the motion of Lord Alfred Churchill, who presided, a hearty vote of thanks was accorded to the lecturer, who, in reply, warmly acknowledged the services he had received from those who had assisted him—Messrs. Ladd, Sugg, Horne, Berly, Willmot, &c.

TELEGRAPH SHARE LIST.

Companies.	Closing Prices Jan. 14.		Business Done Week Ending Jan. 14. Highest.		Lowest.	
Anglo-American Ordinary	58,	⅛	59		58	
Do. "B"	83,	⅛	83⅝		83	
Do. "A"	33,	⅛	34¼		32⅞	
Brazilian	7⅝,	¼	7¾		7½	
Cuba	8½,	9	8 11-16		8⅝	
Do. Ten per Cent. Preference	15½,	16½	15⅞		15⅝	
Direct Spanish	1⅜,	2½	—		—	
Do. Ten per Cent. Preference	11,	½	11½		11¼	
Direct United States	11,	⅛	11¼		11⅛	
Eastern	8 13-16,	15-16	8 15-16		8⅝	
Do. Six per Cent. Debenture	103,	6	106		104	
Do. Five per Cent. do.	102,	4	103½		102½	
Do. Six per Cent. Preference	11⅞,	12	12		11⅞	
Eastern Extension	8 13-16,	15-16	8¾		8⅝	
Do. Six per Cent. Deb.	107,	10	107½		106½	
German Union	8¾,	9¼	9		8 15-16	
Globe Telegraph and Trust	5 3-16,	5-16	5 5-16		5⅛	
Do. Six per Cent. Preference	11⅛,	⅛	11⅛		11⅛	
Great Northern	8⅞	9⅛	9⅛		8⅞	
Indo-European	23,	4	—		—	
Mediterranean Extension	3,	⅛	3¼		2 15-13	
Do. Eight per Cent. Preference	10¼,	¾	10¾		10⅜	
Reuter's	10,	11	—		—	
Submarine	230,	5	232		230	
West India and Panama	1½,	¾	1⅝		1½	
Do. Six per Cent. Preference	7⅜,	⅝	7¾		7⅝	
Western and Brazilian	5⅝,	⅞	6		5⅝	
West. Union Seven per Ct. 1st Mt.	120,	5	—		—	
Do. Six per Cent. Sterling	105,	7	107		106⅝	

TRAFFIC RECEIPTS FOR DECEMBER, 1879.

Companies.	Dec. 1879.	Dec. 1878.	Increase.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	12,624	—	—	—
Cuba Submarine Company	3,000 estd.	3,095	—	95
Direct Spanish Telegraph Company	1,551	940	611	—
Direct United States Telegraph Company	19,670 estd.	—	—	—
Eastern Telegraph Company	45,704	33,467	7,237	—
Eastern Extension Telegraph Company	26,025	22,929	3,096	—
Great Northern Telegraph Company	16,936	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—

ADDRESSES.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

PETER BROTHERHOOD, Engineer, 56 and 53, COMPTON-STREET, GOSWELL-ROAD, E.C.
Specialities—Patent 3-Cylinder Engines (Silver Medal, Paris), as used by Siemens, Gramme, and Wilde for driving Electric Machines.

RANSOMES, SIMS, and HEAD, Orwell Works, IPSWICH.
Specialities—Portable and Stationary Engines, fitted with patent governors, as tried in the electric lighting experiments on the Thames Embankment.

ABBOTT and Co., NEWARK-ON-TRENT.
Specialities—The "Standard Size" Vertical Cross Tube Boilers. Illustrated catalogue, giving every detail of a variety of Boilers, 2s. 6d., post free.

CARBON ELECTRODES COMPANY. Works: 39, COMMERCIAL-ROAD, EAST.
Specialities—Carbon Rods of all sizes for Electric Lighting. Also, Plates and all other Moulded Carbon Goods. List of prices on application.

M. THEILER & SONS, Telegraph Instrument Manufacturers, 86, CANONBURY-ROAD, N. Works: ALWYNE-LANE, N.
Specialities—Morses, Polarised Relays, Saunders' Curb Keys, Type Printers, Recording Sounders, Duplex Apparatus (Theiler's Patent).

HOOPER'S TELEGRAPH and INDIA RUBBER WORKS, MITCHAM and MILLWALL DOCKS.
Contractors for the Manufacture and Laying of Submarine Telegraph and Torpedo Cables. Manufacturers of Hooper's celebrated Insulated Core. Printed reports on application. Offices: 31, LOMBARD-STREET, LONDON, E.C.

THE BRITISH ELECTRIC LIGHT COMPANY (Limited), 41, PARLIAMENT-STREET, WESTMINSTER, and 17, WATER-STREET, LIVERPOOL.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

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SLIP

A KNIGHT OF THE KEY.—Mr. Cornill, the recently-elected Governor of New York, commenced his career as a telegraphic operator.

SOCIETY OF ARTS.—On Thursday evening, January 22nd, a paper, on "The Teaching of Technical Physics," was read by Professor Perry.

DUNDEE.—A telephone exchange is being fitted up at Dundee. The central office is at 4, India-buildings. Bell's system is the one adopted.

DYNAMO-ELECTRIC MACHINE.—It is stated that Mr. W. Elmore, of the American Nickel Company, is bringing out a new dynamo-electric machine with several important improvements.

THE GOVERNMENT AND THE TELEPHONE.—The Post Office authorities have at length adopted the telephone—the combination of Crossley's transmitter with Bell's receiver having overcome their objections to its use.

BRADFORD.—The Town Council has decided to accept the offer of the Telephone Company for the supply of a telephone between the Bradford Town Hall and the Valley-road Gasworks, at the charge of £13 per year.

CARDIFF.—The electric light was tried last month at the Taff Vale Station, with a view of introducing it to illuminate the docks. We are informed that the docks at Penarth will shortly be lighted by three or more lamps.

SYDNEY EXHIBITION.—Messrs. Martin, Hare, and Co., of Sheffield, have a fine display of electro-plate at this Exhibition, as have also Messrs. Walker and Hall, of Sheffield, and the Britannia Company, of Connecticut.

AMERICAN TELEGRAPHS.—The Baltimore and Ohio Railroad Company is extending its system of telegraph lines, having now under construction a line from Parkersburg to Cincinnati, and from Cincinnati to St. Louis.

THE NEW FRENCH CABLE.—Preparations are being made at Porthcurnow or Sandy Cove, between Penzance and Land's End, for the laying of two new cables from Brest to Cornwall in connection with the new French Atlantic Cable.

THE ELECTRIC LIGHT.—It is proposed to employ submarine electric lights in the operations connected with the raising of the submerged girders of the Tay Bridge. Perhaps the mining lamp of Mr. André would prove useful.

PAPER CARBON.—M. A. Vassard, on January 17, writes to the *Globe* commenting on Edison's new departure, and in the course of his letter he says:—"Gas proprietors may slumber in perfect quietness as far as Mr. Edison's new burnt cardboard lamp is concerned."

LONTIN'S INCANDESCENT LAMP.—M. Hospitalier, in *La Nature*, describes this lamp, which consists essentially of a helix of platinum wire placed between two elastic terminals, which, when connected with the battery, elongate or contract the helix according to the amount of electricity used.

THE DIRECT UNITED STATES CABLE COMPANY (LIMITED).—The directors have resolved upon the payment of an interim dividend of 5s. per share, being at the rate of 5 per cent. per annum for the quarter ending 31st December, 1879, such dividend to be payable on and after the 16th February, 1880.

CARLISLE.—The electric light has been successfully used inside Her Majesty's Theatre at Carlisle. We have long thought that its introduction into our London theatres would be merely a work of time, and we hope that the rivalry shown in the country will induce some manager to give it a trial. Success, however, will in a great measure depend upon the electrician employed.

SOCIETY OF TELEGRAPH ENGINEERS.—The first gathering of the Society of Telegraph Engineers will take place on Wednesday, the 28th inst., when Mr. Preece will deliver his inaugural address. Besides surveying the progress of its practical applications during the past year it is reported that he is going to discuss rather fully the condition of our present ideas as to the theory and nature of electricity.

ELECTRO-PLATE.—The demand in the Birmingham district is fairly good both for export and for home consumption. Messrs. Elkington and other firms are developing the system of colour-gilding with much success. The belief seems to be that English electro-plate work is superior to any in the market, and that we are gradually extending our connection to the detriment more especially of our American rivals.

GOVERNMENT AND THE TELEPHONE.—On Wednesday, before the Lord Chief Baron and Justice Lopes, the Attorney General said he had filed an information against the telephone companies with the view of restraining certain wires of which the Postmaster-General had a monopoly. We have several times commented on the antagonism between the Government and the telephone companies, and shall have, in the future, more to say in this matter.

SUNDERLAND.—The Finance Committee, at the last meeting of the Corporation, recommended that the offer of the Telephone Company (Limited) to erect an overhead single strand wire from the town clerk's office, Frederick Lodge, to the surveyor's office, East Cross-street, for the sum of £10 10s., and the free use of a complete set of telephone instruments for one month's trial, be accepted, the Corporation paying the sum of one guinea for the first year for acknowledgment in respect of the said wire.

NATURAL ELECTRO-PLATING.—Some specimens collected in South America by Fremier, director of silver mines at Caracoles, and examined by M. Janneltaz, turn out to be ammonites transformed into native silver. The shell has been in course of time replaced by chloride of silver, and this has further been reduced in part to the metallic state. The specimen throws light on the origin of the native silver in the Caracoles mines, for it is only fair to infer that the metal has in like manner been reduced from the chloride.

THE TELEPHONE.—On Tuesday morning a trial was made at Portsmouth of a system for connecting the police-station and the offices of the Waterworks Company for use in case of fires, by a combination of the telephone and the microphone. By means of a transmitter a speaker can be heard at the other end of the wire without being under the necessity of applying his mouth to the ordinary tube. The intention to send a message is announced by the ringing of an electric bell. The experiments were held to be successful.

TELEGRAPH CABLE ACROSS THE TAY.—One result of the Tay Bridge disaster was seriously to interrupt telegraphic communication between Dundee and the south, several wires being carried across the bridge. The Post Office authorities have reopened communication through Fife by using the cable across the river at Tayport Lights. This cable was laid only a few years before it was abandoned, and on testing it the other day was found to be in very good condition. It contains seven wires, amply sufficient for ordinary requirements.

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THE INSTITUTION OF CIVIL ENGINEERS.—The inaugural address of the new president, Mr. W. H. Barlow, F.R.S., was largely devoted to the consideration of the progress made in applied electricity during the century. Notice was made of the Ronald's telegraph, an account of which was published in 1823, of Professor Barlow's experiments, recorded in the *Edin. Phil. Mag.*, 1825, of the work of Cooke and Wheatstone. "Submarine Telegraphy," "The Electric Light," and "The Electrical Transmission of Power," were respectively considered.

ELECTRO-DEPOSITION.—A contemporary says:—"It is a great mistake to deposit a metal so hard as nickel upon Britannia metal, pewter, or other alloys of a similar character, more especially if the article has to be subjected to heat. The unequal expansion of two metals becomes singularly manifest in the case of a nickel-plated Britannia-metal coffee-pot, for instance, which, after boiling water has been poured into it, frequently exhibits a series of delicate fissures on the surface not unlike the ramifications of a map." The difference in the co-efficient of expansion between the two metals must be so small that only a trained "electro-metallurgist" could find the fissures.

THE NEW YORK TELEPHONE EXCHANGE.—At the Merchants' Telephone Exchange, 198, Broadway, which is controlled by the Gold Stock Telegraph Company, and employing Edison's carbon telephone, there are as many as six hundred lines, radiating out to as many subscribers in different parts of the city and suburbs, Brooklyn, Jersey City, Newark, and Orange, and connections are now being made or projected with all the neighbouring towns. These lines comprise 650 miles of wire. New lines are being erected at the rate of five a day, and it is in contemplation soon to join the Philadelphia central office with that of New York. From four to five thousand calls are made daily at the exchange during business hours, the attendants being provided with a neat hand telephone, combining transmitter and receiver.

LOCOMOTIVE ELECTRIC LIGHT.—A contemporary states that the electric light has been introduced in England for railway use. "To a light, 6 horse-power four-wheel locomotive a dynamo-electric machine is attached, any electric light being used. When the engine is moving along the line, the electric machine rotates at its proper speed, and, when it is necessary to stop, in order that the light may be directed on some particular spot, the driving wheels are thrown out of gear by means of the disengaging handles attached to the pinion on the crank shaft, and the machine ceases to be locomotive, while the engine continues to move the dynamo-electric machine at its proper velocity. The engine is furnished with sensitive governors, so that the speed of the dynamo-electric machine may be accurately regulated, this being very important in order to insure a bright and continuous light." Can any reader inform us where the electric light has been so used?

A RECORDING COMPASS.—This apparatus, for recording the movements of the needle of a compass, is the invention of M. Frederic Alsing, of Copenhagen, and has been adopted on board the steamer Aurore, plying between Kiel and Copenhagen. It is a combination of a compass and chronometer. A little pencil fixed upon the card of the compass traces a diagram, representing the track of the ship, upon a band of paper placed beneath it and drawn past its point by clockwork. Another pencil, connected with this clockwork, traces a second line, which indicates intervals of time. Thus the same band of paper receives two lines, a comparison of which furnishes exactly the deviations from a right line of the track of the ship, the precise moment at which they take place, and in a moment the direction of the ship during the whole voyage. If Sir William Thomson would apply this plan to his corrected compasses we should have a means of automatic "dead reckoning."

THE EDISON TELEPHONE IN USE.—Messrs. J. Eede Butt and Sons, of Littlehampton, have also an office and depôt at Brighton, and these two branches have for some time past been connected by a private telegraph wire, hired from the Government and worked by the A.B.C. code. One of the objections to the telegraph is the slowness with which a conversation can be carried on through it; and to obviate this, and make the communication between their two branches still more complete and expeditious, Messrs. Butt and Sons arranged with the Edison Telephone Company for the introduction of one of Edison's loud-speaking telephones. The same wire is used for both the telegraph and the telephone, the instruments being worked on or off by a switch; and although some little indistinctness is occasionally caused by induction, conversation is at all times perfectly audible, and in spite of the long distance of the circuit (twenty-two miles) the telephone has more than answered everything required of it.

THE CHLORIDE OF LIME BATTERY OF M. NIAUDET.—In this battery the elements are zinc and carbon, the electrolyte a solution of common salt, and the depolarising substance chloride of lime, which, surrounding the carbon element, is contained in a closed porous jar. It has an E.M.F. of 1·6 volt, which is said to remain constant when the external resistance is considerable in relation to that of the battery. It is stated also that there is no local action or consumption of material when the circuit is open; but this we think must be an error, as the calcic hypochlorite contained in the mixture known as chloride of lime is to some extent soluble in water, and must therefore find its way through the porous jar to the zinc, upon which it would have about the same effect as a solution of chlorine in water, which is well known to attack all the metals. The zinc element is maintained in close proximity to the porous jar, and slightly raised above the bottom of the outer jar, in order to avoid the local action due to the contact of the metal with its liberated impurities.

DEATH FROM AN ELECTRIC SHOCK.—An accident of an extraordinary nature occurred on Tuesday night at the Holte Theatre, Aston, a suburb of Birmingham. The stage is lighted by two electric lights, and when the candles are not burning, the connections used for the purpose of crossing the current are hung up over the orchestra. After the performance of the pantomime, Mr. Bruno, the euphonium player, was leaving with the other members of the band, when, presumably out of curiosity, he caught hold of the two brass connections referred to; the man in charge called out to him with the object of warning him of the danger he was incurring. The warning, however, came too late; Mr. Bruno received the full shock of the electric current, generated by a powerful battery which supplies the whole of the lamps in the building and grounds. It is said that the candles not being then burning Mr. Bruno was unable to disengage himself, and pulled the wire down. The shock rendered him insensible. A medical man was at once sent for, and restoratives were applied, but Mr. Bruno died in about forty minutes afterwards.

PAPER WICKS FOR ELECTRIC LAMPS.—In our contemporary *Engineering*, for Jan 16, there is an interesting letter from Mr. Barnard S. Proctor, dated Jan. 13, 1880, stating that many years ago a neighbour of his, Mr. Joseph W. Swan, of Newcastle, employed wicks of paper charred in a

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potter's kiln till hard enough to bear handling, enclosed in a vacuous flask, as an electric lamp. The carbons he produced at that time were grey, with something of a plumbago lustre, sonorous, and with sufficient elasticity to bear a slight flexure. By passing a current through one of these under an exhausted receiver, a beautiful electric light was obtained, and Mr. Swan expressed his conviction that this method would ultimately become the most practical mode of getting a steady electric light. A year or two ago he resumed experiments in this direction, the chief difficulty being to get rid of the troublesome atmosphere of the lamp. His improved Sprengel pump, however, (Swan and Stearn's) and other means which he has taken now promise to yield a satisfactory and permanent light. The chief difficulty to contend with now will be not the getting but the keeping of a proper vacuum. A letter from Mr. Swan himself in *Nature*, for Jan. 1, gives the date of his first application of charred paper loops as fifteen years ago.

The Word "Telegraph."—The word "telegraph" appears to have been naturalised at an earlier date than that given by Mr. Warren de la Rue, who, in a letter to our contemporary *Nature*, publishes the interesting fact that the word "telegraph," though not in the 1810 edition of "Johnson's Dictionary," is to be seen in that of 1818, vol. XXXV., where it is recorded that the word telegraph, derived from *tele*, at a distance, and *grapho*, I write, was brought into use about 1793 or 1794, when the French Directory established machines for communicating intelligence between Paris and all the principal towns of France. The British Government soon after adopted the same fashion, so that the words telegraph and semaphore are both of French origin. The "telegraph" in question was Chappé's semaphore, first tried in 1791. There are several references to it in the *Gentleman's Magazine* for July and December, 1794, and the next three volumes. At first the word is spelled with a final "e," but this sign of its French origin soon disappears. Under date Jan. 28, 1796, we find amongst "Domestic Occurrences" a paragraph stating that "a telegraph was this day erected over the Admiralty." This (says Mr. Richard B. Prosser, of H.M. Patent Office) was removed thirty years ago. Watt, in his "Bibliotheca Britannica," gives a still earlier reference to the word in R. H. Gower's "Theory and Practice of Seamanship."

Edison's New Lamp.—*The Times* does not give the same prominence to the paragraph describing Edison's failure as it did to the telegram announcing his alleged success. Perhaps it is as well. The *Daily News* forestalled it with the information, and therefore the news was old. The following is the paragraph to which we refer:—"The Edison electric lights in Menlo Park are still burning, to the extent of about eighty lamps. Mr. Edison, finding that defective vacuums have developed in a considerable percentage of the lamps, has for several days been experimenting to improve the mechanical construction of the glass globe containing the light so as to insure a permanent vacuum. Mr. Edison's friends report that he is able to overcome the difficulty. Meanwhile, the manufacturing of additional lamps has been delayed, while no arrangements have yet been made practically to use the light in New York." It will be remembered that *The Times* correspondent favoured us with the information that scientific criticism on Edison's work had almost ceased in the States. He would do well to study the *Engineering and Mining Journal*, from which the following extract is taken:—"While not wishing to discourage Mr. Edison or his friends, nor to undervalue the service he is doing to the ultimate demonstration of the practicability of the electric light, we are of opinion that it will be as well to suspend judgment for the present, until at least the latest plan of Mr. Edison has had a few days' trial in practice. The issuing of periodical pronunciamentos from Menlo Park may possibly record substantial scientific triumphs; but there is a growing disposition in many quarters to look upon them in much the same light as Mr. Keely's periodical promises to give a public demonstration of his once famous, but now almost forgotten, motor."

Underground Telegraphy.—Some time ago an official connected with the Postal Telegraph Department was sent to Berlin for the purpose of studying the German telegraph system, but more especially to obtain information respecting the working of the underground telegraph lines in that country. I understand that this gentleman has reported very strongly in favour of the subterranean system, but that the Department hesitate to adopt his recommendations in the face of the large preliminary outlay which they would necessitate. The St. Martin's-le-Grand officials have been in high glee over the unusual phenomenon of a small balance on the right side, and are loth to lose the opportunity of cutting a decent figure in the Budget. In addition to this departmental reluctance, the Treasury authorities are known to have set their faces against the smallest increase of expenditure, and consequently there is, I fear, only too much reason to believe that we shall have to put up with the antiquated absurdity of overground lines for another season or two. It is high time this important matter should be taken into serious public consideration. The benefits of underground telegraphy are well known, and have stood many severe tests during the recent stormy weather on the Continent. The subterranean wires in Germany never once failed, and in France and Holland, where the system has been adopted to a limited extent, similar results were obtained. In England, as we know too well, the interruptions have been frequent and serious; and yet, after all, the aerial system is by far the most expensive, because every storm means large outlay for repairs. Surely money should not stand in the way of this much-needed reform. It should not be forgotten that the telegraphs were acquired by the State for the public good, as is distinctly stated in the Telegraph Act, and not primarily as a source of revenue. The sooner the postal telegraph authorities are made to understand this the better.—*Dundee Advertiser*.

The Brush Light.—This system, recently introduced into England, has had a long career of success in the States. Nineteen-twentieths, says *The Times'* correspondent, of all the electric lights in use in industrial establishments in the United States are those of Mr. Brush. They are employed in cotton factories, rolling-mills, printing offices, and stores. With reference to cost, the experience of the Conant Thread Mills at Pawtucket, Rhode Island, may be cited. There are 38 of the Brush lamps in those mills, replacing 500 gas jets. The cost of the plant is 2,000 dollars, with 65 dollars for each lamp. The carbons are found to cost $1\frac{1}{4}$ cent. per hour per lamp. One man spends a quarter of his time attending them, which will cost three dollars a week. The company finds that the total cost of running the 38 lamps is about one dollar 16 cents. per hour, which is a great saving of expense, because the gas formerly consumed cost five dollars an hour. The Riverside worsted mills at Providence, Rhode Island, have been employing the Brush electric light since February last. The company were sceptical at first, but allowed the light to be introduced in the first instance at the expense of the Electric Supply Company. Twenty lamps were hung in the weaving-room, 110 feet long by 100 feet

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wide, where 110 broad Crompton looms are in operation. The porcelain globes which surround the lamps were painted white on one side, the side toward which the men look; the other two-thirds were clear glass, thus throwing the whole light on their work. The 20 lamps replaced 250 gas-burners. Since February 60 more lamps have been introduced to the mill, and the whole 80 have been subjected to the best test ever made in this country. "Cost of a 16-light machine, 2,000 dollars; cost of double lamps (containing an extra set of carbons into which the current may be switched when the whole set is burnt), each, 80 dollars; number of gas-burners replaced by the 80 lamps, 1,000 dollars; cost of 1,000 gas-lights formerly per hour, 12 dollars 25 cents.; cost of 80 electric lights per hour, 80 cents.; candle power of the 1,000 gas jets (15 by 1,000), 15,000; candle power of 80 electric lamps (2,000 by 80), 160,000." Of course, less light would answer in the factory, but the increase of illumination is very much liked. The light is strong, steady, and fine.

Spectrum of the Electric Spark between Magnesium Points.—Professors Liveing and Dewar have been examining the spectra of magnesium in hydrogen with the following results. The discharging points were pieces of magnesium wire. Round one end of each a platinum wire was tightly coiled and fused into the side of a glass tube. This tube was attached by fusion at one end to another tube filled with phosphoric anhydride, which in turn was connected with a Sprengel pump. The other end of the tube, with the wires, was connected by a thick rubber tube, capable of being closed by a pinchcock, with a gasholder containing nitrogen over strong sulphuric acid. The tube having been exhausted and filled with nitrogen two or three times, it was found that no line at 5,210 (wave-length) was visible in the spark. The tube was now gradually exhausted, and the spark watched as the exhaustion proceeded. No line at 5,210 was seen, although the exhaustion was carried nearly as far as the pump would carry it; nor was any hydrogen line (C or F) visible, either with or without the use of a jar. The communication with the gasholder was now opened, and the tube refilled with nitrogen at the atmospheric pressure. A communication was then made with another vessel, containing hydrogen, which was allowed to diffuse into the tube for a very short time. On now passing the spark, the line at 5,210 at once appeared, although the quantity of hydrogen diffused into the nitrogen must have been very small. The experiments with nitrogen at reduced pressure were repeated several times, with the same result. It was found necessary to have the phosphoric anhydride, as without it traces of moisture were left or found their way through the pump into the tube, and then, when the exhaustion was carried far enough, both the line at 5,210 and the hydrogen lines, C and F, made their appearance. We have never, however, been able to detect the line at 5,210, in nitrogen, without being able to detect C or F either at the same time or by merely varying the discharge by means of a Leyden jar. Experiments made in the same way with carbonic oxide instead of nitrogen led to precisely similar results. The line at 5,210 is not seen in the "arc" in a lime or carbon crucible when magnesium is dropped in without the introduction of hydrogen. If, however, a gentle stream of hydrogen or of coal gas be led in through a perforation in one of the electrodes, the line at 5,210 immediately makes its appearance, and, by varying the current, it may be made to appear either bright or reversed. However small the current of hydrogen be made, the line can be detected as long as the current and the supply of magnesium continue, and disappears very quickly when the current ceases.

LITERATURE.

Lightning Conductors, their History, Nature, and Mode of Application. By Richard Anderson, F.C.S. [E. and F. N. Spon.]

(concluded from p. 101.)

The custom of connecting the lightning conductor with the weather-cock rendered it necessary that Mr. Anderson should also consider the connection between the two. He does not take very freely to weather-cocks; he doubts whether they are of any great use, even in demonstrating the direction of the wind, whilst there is little doubt that they provide a weak point in a chain that should have no weak point. We then have a description of the methods used in France and America. The following chapter (xiii.) is one of the most interesting and important in the whole book. It deals with the English system, and more especially with that of Mr. Newall. Practical examples of the effect of the lightning stroke are given, and the why and wherefore of evil results thrashed out so completely, that only the veriest dolt of a reader can fail to comprehend how thoroughly, how exhaustively the subject is treated, and how fully the author has made his work a labour of love. The theory of protection is simple—the conductor "must form the best path which can possibly be made for the electric force. . . . It is not always easy to find the reason why the lightning takes any particular path; but one thing is certain, that is, it acts under certain fixed principles, and does not take any particular route by chance, but always because it is the line of least resistance." The result of Mr. Newall's investigations lead him to conclude that only two metals, iron and copper, are practically available for use as lightning conductors, and that, on the whole, copper is preferable to iron. It is a better conductor, as six to one, and therefore weighs about six times less than iron of the same conductivity, it rusts with greater difficulty, it is more easily adapted to the angles of buildings, but, on the other hand, it is more expensive at first. This chapter contains diagrams of various styles of houses, &c., showing how the conductor should be affixed, and concludes with an adverse criticism on the late Prof. Clerk Maxwell's suggestion "to convert a building into a closed conducting vessel by a sufficient number of wires enclosing it." The concluding portion of the work is a "sermon" which requires to be dinned into the ears of the English nation. We speak of ourselves as characteristically possessing a fair share of "common sense;" of being a "practical people." The perusal of these three chapters gives us the "lie" direct. We are undoubtedly criminally careless. The majority of our private houses, many of our public buildings, numbers of churches, and even cathedrals are left unprotected against lightning. "A glaring instance of the absence of protection against lightning is to be found at Windsor Castle. It is a fact that several portions of this splendid palace, among them St. George's Chapel, and the adjoining Belfrey Tower, are entirely unprovided with lightning conductors." The list of public buildings, &c., struck by lightning fills no less than twelve pages, and, of course, any such list is necessarily very incomplete, however great the labour expended on its compilation. The importance of good earth connection is emphatically maintained, the concluding sentences on this subject being:—"A recent writer on lightning conductors, whimsically, yet with much truth, expresses it (the necessity of good earth contact) by remarking that 'people spend money upon gilded points on the top of the house, while they ought rather to sink it in water at the bottom.' Undoubtedly, the efficiency of conductors lies, even more than at the top, on the bottom. The earth connection may be called 'the Alpha and Omega' of lightning protection." Having fixed a good lightning rod upon the most approved principle, with good earth connection, it is even then impossible to sit down and rest. Periodical and careful testing is a necessity. Mr. Anderson says:—

"The causes which necessitate such inspection are numerous. In the first instance, there is the constantly acting influence of wind and weather upon those parts of the conductor which are above earth. Wonderful as is the simple machinery devised by Franklin, which conducts the mysterious electric force from the clouds into the ground, depriving it of its destructive power, it is, after all, but a feeble thing in itself, and necessarily so. The upper terminal of the conductor—what the Germans call the 'reception rod,' and the French the 'tige,' or stem—cannot be very thick without becoming unsightly, and, as regards large public buildings, destroying their architectural effects; while the rope, or ribbon, running to the ground must, for the same reason, as well as that of cost, be of comparatively small diameter. Subject to the constant effects of moisture, to wind, and ice, and hailstorm, there is always a possibility of the slender metal strips being damaged so as to interrupt their continuity, and thus destroy the free passage of the electric force. Instances have

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happened in which the damage done was so slight as to be scarcely visible, and still sufficient to destroy the efficacy of the conductor. Nothing but the regular testing by a galvanometer —one of which is described with an illustration on page 60—by an experienced person can establish the fact that the action of the conductor remains perfect.

"A second important cause for inspection lies in the necessity of always ascertaining with accuracy whether the earth connection is really in a faultless state. The immense significance of the earth connection—the basis, in more than one sense, of lightning protection—having been dwelt upon in the preceding chapter, it is only necessary here to state that, even if perfectly secured at the outset, it is liable to disarrangements. One not unfrequent accident causing them is a change in the soil from moisture to dryness, which may be brought about either by altered drainage or long absence of rain. The dangers which threaten a break in the earth connection by altered or improved drainage are of the most serious kind, and likely to become more so from year to year. Not only the soil of our towns and cities, but even that of our villages, and the fields themselves, is getting ever more honey-combed by drain pipes, until almost every drop of moisture is sucked out of the ground. No doubt the pipes themselves may improve the earth connection, if of iron or any other metal. But very frequently they are of earthenware, in which case they are far more dangerous than useful, even if filled with water. To guard against the danger likely to arise from changes in the drainage, it would be wise to have a thorough examination, by means of the test galvanometer, of all lightning conductors near to or affected by alterations in the drains, whenever completed. The same recommendation may be made as regards cases where the soil has become unusually dry after a long absence of rain. Few persons, except those who have made a study of the subject, can form an idea to what depth such dryness often extends, more especially in sandy and gravelly soils.

"There is a third ground, as material for consideration as each of the two preceding ones, upon which the regular inspection of lightning conductors must be strongly urged. It is, that constant alterations in the interior of buildings, private residences as well as public edifices, may serve to destroy the efficacy of a conductor which was originally good, even to perfection. Thus a roof may be repaired, and lead or iron introduced where it was not before; or clamps of iron may be inserted in the walls of houses, to give them greater strength; or, in fact, any changes may be made which bring masses of metal more or less in proximity to the conductor. Under such circumstances the efficacy of the conductor is destroyed, just in proportion as the metal forms a better path for the dispersion of the electric force than the one artificially prepared. There are hundreds of instances to prove that changes made in buildings, such as the addition of a leaden roof without, or the iron balustrade of a staircase within, diverted the current of the electric force from the conductor on its way to the earth, originally well provided for. In one rather curious case, which happened at Lyons not many years ago even, an alteration of the fixtures of a house proved destructive to the efficacy of a conductor perfect at the outset, the latter fact being shown in that it had previously received a stroke of lightning and brought it harmlessly to earth. The case was that of a banker possessed of the piece of furniture indispensable to his profession, namely, a large iron safe. It stood at first near an inner wall, in the centre of the house, but wishing to add to its strength in resisting the attack of burglars, the banker had it imbedded partly in another wall adjoining that on the outside, near a place where the masonry was held together by some large iron clamps. In delightful ignorance, which would have been the same, probably, among 999 persons out of 1,000—the banker sat quietly down to dinner with his family one day in July, when a terrific shock made the whole house tremble to its foundations, upsetting furniture, and breaking glasses. The idea of an earthquake naturally came up at once; but on looking out of the window (shivered to pieces) the banker was told by a crowd assembled outside that there had been no earthquake, but that his house had simply been struck by lightning, as it had been before. But, while previously the electric force had passed silently into the ground, unknown even to the inmates of the house, and its passage verified only by the accidental observation of a neighbouring meteorologist, it had this time left its appointed path seeking a new road into the banker's safe, filled with gold. Once inside, the electric current, not finding a further outlet, had expended its force in shattering the walls and making the house tremble, besides melting some gold and burning bank notes. The investigation of the case at the time made some noise, but it had one most useful result—it led to the institution of a new office in connection with the Department of Public Architecture of the City of Lyons, that of an inspector of lightning conductors. He was charged to examine at stated intervals, or as often as circumstances seemed to require it, the conductors applied to all the public buildings of the city, to ascertain their efficacy, and, if not deeming them in good condition, to effect all necessary repairs. Shall we repeat again and again, 'They manage things better in France?' The regular inspection of lightning conductors, as yet unknown, or all but unknown, in England, has been for a long time in practice in several States of Continental Europe, among them Germany and France. The origin of such inspection may be traced to northern Germany. It has been mentioned before (chap. IV., page 43) that the first lighting conductor set up over a building in Europe was erected on the steeple of the church of St. Jacob, Hamburg, and that the extension of conductors in the city and neighbourhood was so rapid that before five years had gone by there were over seven hundred conductors. 'To this day they are comparatively more numerous in this district than anywhere else in Europe.' To this day, too, the scientific aspect of the question of lightning protection, and the statistics connected with it are more appreciated here, and have been more closely investigated, than in any other part of Europe. In recent years this has been more particularly the case in the territories to the north of the city of Hamburg, the German province of Schleswig-Holstein. Not even in the country of their origin, and the one which, as yet, has the greatest number of them in use, have the 'Franklin rods' given rise to so much serious study as in that part of Germany."

We have, we hope, shown that Mr. Anderson's book is not only good, but is the best of its kind, and deserving the careful attention not only of every student, but of every householder.

COUNT TH. DU MONCEL ON EDISON'S LAMP.

In an article on this subject in *La Lumière Electrique*, M. du Moncel expresses astonishment at the excitement caused in the Money Market by the praises bestowed on the lamp, which is called "a great discovery." M. du Moncel thinks the public must have forgotten the existence of such things as American *canards*, to accept such pretensions. "Edison," says the writer, "is an ingenious and fertile inventor, but is not well versed in the subtleties of electric science, nor acquainted with the discoveries made before his time. Neither the idea of the telephone nor the realisation of the phonograph belongs to Edison. His first lamp was a modification of the one invented by Changy in 1858. The one now announced is the modification of those of several inventors, viz., King, Lodyguine, Bouliguine, and Sawyerman. It does not even possess the ingenious arrangement of M. Konn's lamp, which prevents the extinction of the light in case of a rupture of the incandescent carbon. In 1875 much noise was made about the incandescent carbon lamp of Korloff, the pretension being that one Alliance machine could feed fifteen lamps, and yet no more than two have ever been seen working. Regnier and Werdermann by adding the voltaic arc to that combination obtained better results. And now Edison makes a retrograde movement, and revives the Lodyguine lamp under a new form. The small carbon needles are replaced by laminated carbon, or carbonised Bristol paper separated by metallic tissues carved into the form of a horse-shoe, and joined to the terminals of the circuit by platinum wires, the whole in vacuum, as in Lodyguine's system. That arrangement may be better than anything previous, but is not an invention of the importance assigned to it by the American papers. The idea of intercalating metallic bodies in the carbonised mass is not new, for it had been realised by Jablochkoff and Kelmer. It is difficult for the carbon horse-shoe, so loose and delicate, not to be deteriorated by prolonged incandescence on account of the caloric action disintegrating the carbonic particles and the mechanical action of the current which carries them away and deposits them on the sides of the recipient as in Geissler's tubes. The metallic tissues separating the layers of carbon would be damaged. As for the greater brilliancy of the light with vegetable carbon, a peculiarity which, according to the American papers, constituted the great superiority of Mr. Edison's system, I must again say that this phenomenon was noticed long ago." To prove this statement the writer quotes at length from some articles on the Rumhkorff machine, published by him as long ago as 1855 "Experience alone will be able to decide, and it is prudent to wait, in spite of the announcement of fifty or sixty foci fed from a single machine. The same may be said of the dynamo-electric machine, which offers nothing new about which the theories put forth would upset the laws of Ohm and Joule, theories which are at variance with the experiments made with every other machine. Edison has paid no attention to the maximum effects."

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THE ELECTRICIAN.

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ELECTRO-DYNAMIC TRANSMISSION.

On a previous occasion we referred at some length to the value of the electric current as a means of transferring the now unutilised power of many waterfalls to places distant therefrom. This application of dynamo-electric and electro-dynamic machines seems, however, to be of such great importance that we do not hesitate to return to it. This we do more especially to urge that it is not alone those places which are situated within a convenient radius of a waterfall that may be supplied with power by electric transfer. There are innumerable situations round our coasts and on the shores of some of our estuaries whereat advantage might be taken of the potential energy of the waters of the high tides. The tide mill was a useful servant in days preceding the advent of the steam engine, but there are now good reasons for thinking that the rejected servant may, in a modified form, have another day. The possession of the modern turbine will remove many of the difficulties belonging to the old wheels, and the appliances which the mechanical engineer has placed in the hands of the modern contractor will make it possible to entertain a project the cost of the realisation of which would, in the early part of this century, have been prohibitory.

In order to make use of the rise and fall of the tide for our purpose, three principal things are required: (1) Two large water reservoirs involving usually (2) embankments and separation walls and considerable excavation; and (3) a pair, as a minimum, of turbines. Large excavations can now be made in the materials forming the most of our shores at a very small cost. By means of the modern steam excavator this work has been done in stiff clay at from 4·75 to 8·5 pence per cubic yard. For the necessary dam or wall, concrete may be employed with great economy as compared with the masonry necessary a century since. Turbine wheels are now to be purchased from engineers who have for years made this motor a speciality, and who now make turbines which will give off an effective duty of 75 to 85 per cent. It may, therefore, be safely assumed that the necessary works for utilising the vertical range of tidal waters may be constructed at a cost vastly less than such works cost when previously employed.

The mean vertical range of ordinary spring tides has a widely different value on different parts of our shores. The greatest available range is at Chepstow, where it is 40 feet; at Bristol it is nearly 40 feet; and in Mount St. Michael's Bay it is 46 feet. These are, however, exceptional cases. At London Bridge it is 19·5 feet, Liverpool 26·0 feet, Portishead 35·75 feet, Holyhead 16·08 feet, Hull 20·82 feet, Devonport 15·5 feet, Portsmouth 12·70 feet, Sheerness 16·0 feet, Harwich 11·5 feet, Great Grimsby 19·16 feet, Leith 16·33 feet, Pembroke 21·5 feet, Weston-super-Mare 37·25 feet, and at most other sea-side places the ranges vary from 10 feet to as high as those quoted. Now, one-half to three-fourths of the tidal range is utilisable as effective head for working water motors. Taking, therefore, the average available working head as 10 feet, we have, as the quantity of water theoretically necessary to develop one horse-power $\frac{33000}{10} = 3{,}300$ pounds per minute. To this, however, we must add say 25 per cent. as the difference between unity and the effective duty of turbines, and again 5 per cent. for leakage; and we then have 3300 + 825 + 165 = 4290 lbs., or, say, 68 cubic feet of water necessary to develop 1 horse-power per minute. The water storage or reservoir area necessary will depend upon the system of working adopted. That which seems to recommend itself most is the system which requires two adjacent reservoirs worked as follows, each reservoir being provided with a pair of turbines, one of each pair being for use in case of derangement of the other. The turbines of each reservoir will be connected by suitable clutch gearing to the same main shafts for operating the dynamo-electric machines. Then, calling the two reservoirs E and F, we will suppose F to be full to high water level, and, further, that it is now high water. The working turbine in E, working by inflowing water, is started two hours, say, before high water, and thus, having been at work two hours, it will continue to work until, say, half ebb. The turbine in F is then started, that in E stopped, and E allowed to empty itself by a sluice with the remainder of the ebb tide, the sluice being closed at low water. The turbine in F is worked by the water flowing therefrom, and may continue to work until, say, half flow

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tide, when the turbine in E will be again started, and the process being repeated, a continuous supply of power to the dynamo-electric machines will be secured. By this system of working it will be seen that each reservoir should have a storage capacity equal to that quantity of water which is necessary to supply the turbine for three-quarters of a double tide, or nine hours. In order, however, to allow a margin of capacity sufficient to permit working considerably more than half a single tide by each turbine, we may take the necessary capacity as that which will supply the turbine for twelve hours. We have already seen that the quantity of water required per minute per horse-power will be 68 cubic feet. The quantity required per horse-power for twelve hours will, therefore, be $68 \times 60 \times 12 = 48{,}960$ cubic feet, or, say, 1,813 cubic yards. Taking the necessary depth of the reservoirs as 15 feet to allow an available head of 10 feet, we have $\frac{48960}{15} = 3264$ square feet as the necessary superficial area of the reservoirs; or, supposing the reservoirs to be square, they would be 57·13 feet on each side. One horse-power would not, of course, be of any value, but having the requirements for one horse-power, we may easily get at that required for any other number. Taking, for instance, such a town as Devonport, with about 50,000 inhabitants, it will be readily admitted that, for electric lighting and other purposes, the power of 600 horses, or 600 steam-engine-indicated horse-power, would be readily utilised. Assuming, and it is very near the truth, that 60 per cent. of the work done upon a dynamo-electric machine is realised from an electro-dynamic machine, then the horse-power required would be 1,000. It would be less in proportion to the quantity of electricity that could be used directly for lighting purposes, but we will take 1,000 horse-power as being required. The reservoir area required will then be $\frac{48960 \times 1000}{15} = 3264000$, or a lineal extent of embankment, even if embankment be required throughout the perimeter of the reservoir, of about 7,230 feet, and requiring but 1·8 million cubic yards of excavation. It would, however, happen in most cases that the earthen embankments left by the excavation would answer all requirements, except just at the sea face and at the turbine house. Taking one horse-power as vendable at the very low rate of 6d. per horse-power per day, then we have a rental of £15 per day, or, for only 300 days per year, an income of £4,500 per annum. This, capitalised at 8 per cent., equals £56,250. Thus, taking the extent of the necessary reservoir work (the most costly) at the very extreme estimate, it may be assumed, without entering into the details of cost of machinery—details which we may leave to our engineering contemporaries—that the cost of works and apparatus would leave a very large margin for profit. Sufficient, at least, has been said to show that there is a great future for the employment of dynamo-electric machines in connection with hydraulic engineering work, and it may be safely said that tidal power may be almost as efficiently and cheaply utilised for 20 as for 2,000 horse-power.

CORRESPONDENCE.

ELECTRICAL STORAGE.

TO THE EDITOR OF THE ELECTRICIAN.

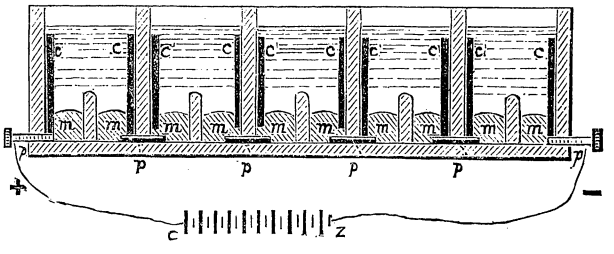
SIR: In No. 9, Vol. iv., just received, I find on pages 100, 101, a description of a battery for storing up electricity. Such a battery has been used by me for transmitting the time signals received from the Astronomer-Royal, Greenwich, to all parts of Great Britain and Ireland. I send you herewith a description of the apparatus, which description has been forwarded to almost every civilised country where telegraphs exist. The polarisation battery used consisted as under:—60 cells accumulator; 150 cells Daniell of great resistance, as charger.

The cells of the accumulator were made as shown in diagram. The overpowering effect of the Daniell battery deposited zinc in and upon the zinc plate (afterwards a carbon plate was used), and formed sulphate of mercury on the surface of the mercury and carbon plate.

Thus we have a sulpho-mercury-zinc battery formed. The cells were charged with a solution of sulphuric acid *one*, water *four*, and this was saturated with sulphate of zinc. The zinc was quickly deposited on the one side upon the carbon which was coated with amalgamated zinc. The other side, as far as the mercury was concerned, was covered with persulphate of mercury and the carbon partly with persulphate of mercury, and oxygen in an active state, probably as ozone. This battery, after being charged with 150 small Daniell cells for a considerable time, would give a voltaic arc, between carbon points, varying from $\frac{1}{2}$ inch to $\frac{1}{4}$ inch, for twenty or more minutes, while the charging battery alone would only give a faint spark between carbon points, and would not heat a platinum wire $\frac{1}{3000}$ part of an inch in diameter. The stored-up charge would burn iron wire $\frac{1}{100}$ part of an inch in diameter rapidly.

This battery, and all the chronofer arrangements I had invented and constructed, received encomiums from the Astronomer-Royal, who, after examining the whole arrangement, did me the honour to write a letter stating he could not see room for any further improvement.

I am not now connected with the Post Office, but I believe the battery is still in use; in fact, it would not be easy to find so cheap and effective a means of sending powerful currents of great volume by any other method, for they are only required at 10 a.m. and 1 p.m., for one second duration in the twenty-four hours.—Yours, &c., CROMWELL F. VARLEY.



DESCRIPTION OF FIGURE.—The trough shown consists of five cells, and is made of gutta percha. In the middle of the cell is a gutta percha division $1\frac{1}{4}$ inches deep, the cells being $4\frac{1}{2}$ inches deep; $\frac{3}{4}$ inch of mercury, at *m m*, &c., was poured in, and the cell filled with sulphuric acid and sulphate of zinc. C′ becomes charged with oxygen, while the mercury is charged with persulphate of mercury. C becomes coated with amalgamated zinc, the platinum wires connect cell to cell, and the terminal platinum wires $p + p -$ are connected to the instrument to receive the accumulated electromotive force.

MAGNETIC APPLIANCES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The curative efficacy of magnetic appliances has been tested for several years by all classes of society, and they have freely given their testimony. This testimony has been published, and no evidence could more clearly and conclusively prove the curative efficacy of magnetism. The appliances contain a certain number of magnets. These supply to the system magnetic force, thus generating heat and stimulating the circulation. By wearing magnetic appliances the general circulation is constantly promoted and sustained. Magnetic treatment has this advantage over chain bands and electric batteries. In the latter case great care is required in using the battery, or the electric shocks may seriously affect the nervous system, but the gentle, soothing, and continuous influence of magnetism is helpful both to children and adults. Magnetic force as it enters the body has the same curative power as the electric current received from an electric battery, but as the magnetic current is continuous and most penetrating it may be received for health purposes as the most safe and efficient method in the treatment of disease. For several years I have marked the influence of magnetic appliances upon persons suffering from general and nervous debility, spinal complaint, chest weakness, bronchitis, rheumatism, &c., and the cures effected have been remarkable. When powerful magnetic

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appliances are used in almost every home the general health of the people will be promoted and their happiness increased.—Yours, &c., J. WILKINSON.

15, St. Laurence-road, North Kensington.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue for January 17th I see a letter from A. J. Lewis asking three questions, which you answer, editorially, in a most dogmatic manner. Although I have studied these questions closely for some years, I am not in a position to reply to them in the same off-hand manner that you do.

Question No. 1 is—"Do magnetic appliances when worn upon the body produce electric currents?" Your answer is "No." Perhaps you are right if you must say either yes or no; but they produce magnetic currents, which we all know closely resemble, and are intimately allied to, electric currents.

No. 2—"Have they any curative efficacy?" To which you reply, "In our opinion they have no such efficacy, or at least none due to their *magnetism*." I have been experimenting practically with Wetton's magnetic appliances for the last four years, and I am clearly of opinion that they are decidedly efficacious in a large number of cases, and that due to their magnetism.

The last question of course requires no answer, being absurd, their being no analogy, no more than there is between a telephone and a voltameter.—Yours, &c., HARRY LOBB.

31, Sackville-street, Piccadilly, Jan. 19.

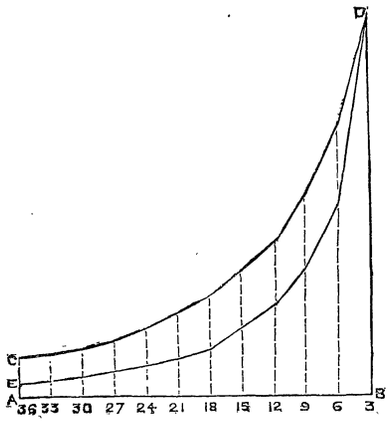
NOTE ON THE SHAPE OF THE ARMATURE AS AFFECTING MAGNETIC ATTRACTION.

BY R. H. RIDOUT, F.C.S.

In seeking a choice of shape for the armature of an electro-magnetic engine, a steel magnet 2½in. long was used, and its attractive power at varying distances observed. The armature was a piece of wrought iron sheet—charcoal annealed—long enough to cover the poles, ¼in. wide and $\frac{1}{32}$in. thick. One side was filed accurately flat, and one edge made semicircular in section, so that when placed on the poles it would remain at any angle. The magnet and armature were separated by interposing slips of paper—foreign post—the size of the latter between them. The paper used was found to be $\frac{1}{500}$in. thick. A light box fastened by a hook to the armature supported the weights, which consisted of leaden shots. Each of the values was determined several times, and the observations continued till constant results were obtained.

In the first trials the magnet was fixed poles downward to a frame, but there was so much difficulty in suspending the armature perpendicularly to the magnetic poles, that the results were untrustworthy, and the method was abandoned in favour of the more tedious manual one.

It was noticed that when for a certain distance the limit of weight was nearly reached, the armature seemed to float beneath the slips of paper, and the slightest inclination of the magnet caused it to slide off. It was here that the manual method showed to advantage, as the exact position after a time came to be recognised by muscular sensation.



The attractions were measured at intervals of one thickness of paper—$\frac{1}{500}$in.—and the following relative numbers are taken at intervals of three. Seven being the relative weight of the armature and box, the determinations could not be continued further. The numbers for contact, too, are omitted. The "floating" sensation could not be got, and, therefore, the results would not be strictly comparable with the others:—

Face of Armature.		Edge of Armature.	
Distance.	Attraction.	Distance.	Attraction.
3	345	3	345
6	175	6	123
9	130	9	82
12	100	12	58
15	80	15	42
18	65	18	31
21	55	21	24
24	45	24	20
27	35	27	16
30	28	30	12
33	25	33	9·5
36	22	36	7

In the diagram these numbers are set out as ordinates.

C D is the curve for the flat side, and E D for the edge of the armature. It will be seen that the total attraction for the flat side between the interval $\frac{3}{500}$ and $\frac{36}{500}$ = area of A C D B, and A E D B for the edge; but that if E D were continued to cut the ordinate O, it would do so at a higher point than C D. Hence while the edge is more powerfully attracted at contact, the flat side is more effective through a sensible distance.—*Engineer*.

STUDIES ON THE ELECTRIC ARC.*

BY JAMES DEWAR, F.R.S.,

Professor of Natural Philosophy in the University of Cambridge.

In my former communication on the formation of hydrocyanic acid in the electric arc, a more complete examination of the various reactions taking place in the arc with poles of various kinds, and in the presence of different gaseous media, was promised.

Various difficulties have impeded the progress of the investigation, but during the numerous experiments made, many facts of interest were ascertained, which appeared to be worthy of embodiment in a short paper.

Formation of Hydrocyanic Acid.

The influence of the impurities of the carbon on the production of the hydrocyanic acid was first examined. For this purpose, some drilled Siemens' carbons were placed in a porcelain tube, and treated for several days at a white heat with a rapid stream of chlorine, until the greater part of the silica, oxide of iron, alumina, &c., were volatilised in the form of chlorides. Sometimes the carbons had a subsequent treatment of hydrogen, or were directly treated with a current of chlorine while the arc was in operation.

Carbons treated in this way continued to yield hydrocyanic acid, when air was drawn through the positive pole as formerly described, even when the same positive pole had several successive treatments with chlorine in the arc.

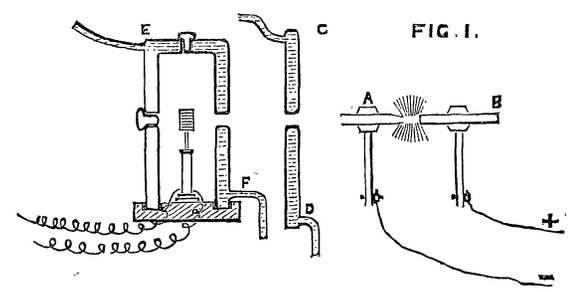


FIG. 1.

As it was evident from the foregoing experiments that the elimination of a large portion of the impurities had little influence on the production of the hydrocyanic acid, the only other explanation of its formation appeared to be the presence of aqueous vapour or organic impurities in the air. An attempt was, therefore, made to obtain a pure and dry atmosphere in which to examine the arc, the following apparatus being devised for the purpose:—

A tin vessel, about 2 feet high and 1 foot in diameter, having an annular space all round it, through which a constant stream of water was kept flowing, was placed upon a porcelain stand, having a narrow groove round it filled with mercury, so as to make an air-tight joint. The lamp was then placed inside this vessel, the wires connecting it with the machine being brought through two holes in the bottom of the stand; there was also another hole through the bottom, for forcing dry air into the

* Abstract of a paper presented to the Royal Society.

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vessel, and a hole through the top for the glass tube coming from the positive pole, and through which the products of the arc were drawn. This annular vessel was very convenient, not only for examining the products of the arc itself, but also those formed outside of it, and the water flowing round it served the double purpose of keeping it cool during the working of the lamp, and determining the amount of total radiation in heat units, as will be subsequently described.

Several vessels with pumice stone and sulphuric acid, and one with phosphoric anhydride, were placed inside the cylinder in order to dry the interior as completely as possible.

Numerous experiments were made, forcing perfectly dry air into the vessel through the tube A, and drawing it out by the tube B through a weighed sulphuric acid bulb, and when this was continued for about an hour a few milligrams of water were always obtained, owing, no doubt, to some slight defect in the soldering of the tin, which allowed a capillary film of water to diffuse into the interior space.

When the ordinary Siemens' carbons were burnt in this almost perfectly dry atmosphere, the yield of hydrocyanic acid was still very marked, purified carbons yielding the same results.

As the yield of hydrocyanic acid was as large as ever, and it appeared almost an impossibility to get the large volume of air in the tin vessel perfectly dry, another plan was adopted, only the two poles being enclosed in an egg-shaped glass globe about 8 inches long and 6 inches in diameter, then diminishing the volume of air to be dried and dispensing with the water covering. The globe was balanced by a system of pulleys, and was then firmly attached to the lower or negative pole, with which it moved up without impeding the action of the lamp.

The dry air was sometimes forced through the negative carbon itself, and at other times through a glass tube passing up the side of it into the globe, the products being drawn out of the positive pole as before.

As the globe soon became intensely heated by the arc, and as a far larger supply of dry air was forced in to what was drawn out, it is inconceivable that any moisture could remain near the arc after it had been burning for a few minutes.

Purified carbons were used, in some cases as many as seven consecutive experiments, of ten minutes duration each, being made with the same carbon; but the quantity of hydrocyanic acid did not appear to be in the slightest degree diminished.

The inference to be drawn from these experiments was, that the drilled carbons, even after prolonged treatment with chlorine, still contained a quantity of combined hydrogen, and a few organic analyses showed that the amount of ash and combined hydrogen in the various samples was never less than about ·75 of ash and as much as ·2 of hydrogen. Poles made with especially purified carbon by Messrs. Siemens for these experiments proved to be no better in this respect, and it is therefore certain that poles made with chemically pure carbon from graphitic acid must be used for the prosecution of this research.

The almost impossible problem of eliminating hydrogen from masses of carbon such as can be employed in experiments of this kind, proves conclusively that the inference drawn by Mr. Lockyer, as to the elementary character of the so-called carbon spectrum from an examination of the arc in dry chlorine, cannot be regarded as satisfactory, seeing that undoubtedly hydrogen was present in the carbon used as the poles.

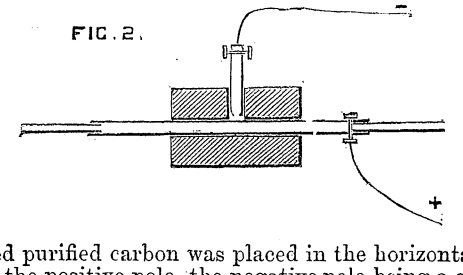
What channels in the carbon spectrum may be due, as surmised by Angström and Thalén, to compounds with nitrogen, must be considered uncertain.

Experiments with Carbon Tubes.

In order to ascertain whether the formation of hydrocyanic acid and acetylene in the arc was really due to transformations in the arc itself, or was only the result of the high temperature attained by the carbons, a series of experiments was made in horizontal carbon tubes, the arc being merely used as a means of heating the tubes, the following being the method adopted.

A block of limestone about 5in. long by 3in. thick was drilled through horizontally as shown in the drawing, another hole being drilled vertically so as to meet it in the centre.

FIG. 2.



A drilled purified carbon was placed in the horizontal hole and was made the positive pole, the negative pole being a solid rod of carbon passing through the vertical aperture. The gases were passed through the positive carbon, and were then subjected to the intense heat of the pole, the arc passing on the outside.

One of the great difficulties was the rapidity with which the walls of the positive carbon burnt through, not lasting as a rule more than fifteen minutes, and this could only be obviated by using much thicker carbons, and consequently reducing considerably the amount of heat.

Another difficulty was the porosity of the carbons, which allowed a constant diffusion of gases through them.

On passing a mixture of 3 volumes hydrogen and 1 volume nitrogen thoroughly dried through the positive pole, a large yield of hydrocyanic acid was always obtained, and on using equal volumes of hydrogen and nitrogen the quantity was if anything increased.

Pure dry hydrogen by itself gave a trace of hydrocyanic acid, and a considerable quantity of acetylene.

Pure dry air gave no hydrocyanic acid or acetylene, moist air, on the contrary, giving abundance of the former, but only a trace of the latter.

The yield in all these experiments altered considerably with the rate at which the gases were passed, a quick stream always producing more than a slow one.

Formation of Nitrites in the Arc.

In these experiments the annular vessel was made use of, in which the lamp was allowed to work automatically often for an hour or two together. A continuous stream of dry air was kept circulating through the interior, being afterwards drawn sometimes through a series of wash bottles containing dilute caustic soda, and sometimes directly through strong sulphuric acid to absorb the oxides of nitrogen; being estimated in the former case by titration with permanganate of potash, and in the latter case by the mercury process.

In this way many experiments were made with Siemens' carbons, using both a long and short arc, and also with Jablochkoff's candles, using the highest intensity current.

The stream of dry air was forced through at varying degrees of speed, which was found to have a decided effect on the quantity of nitrites produced, the more rapid stream giving the largest yield of nitrites.

The following tables show the quantity produced in a number of experiments.

The nitrites were calculated as HNO_2.

1. Siemens' machine and lamp. 2. Jablochkoff candles.

—	Nitrates produced in 1 hour		Highest intensity current.
	Long arc.	Short arc.	
	Mgrms.	Mgrms.	Mgrms.
1st experiment ... =	193	28	769
2nd ,, ... =	804	97	723
3rd ,, ... =	618	73	1,225
4th ,, ... =	500	121	548
5th ,, ... =	622	90	955
6th ,, ... =	474	85	1,006
7th ,, ... =	380	...	1,257
8th ,, ... =	459	...	964
9th ,, ... =	...	...	664
10th ,, ... =	...	...	489
11th ,, ... =	...	...	693
=	509 mean	...	930 mean

(TO BE CONTINUED.)

EASTERN TELEGRAPH COMPANY (LIMITED).

The fifteenth half-yearly ordinary general meeting of the shareholders in this Company was held on the 22nd inst., at the City Terminus Hotel Cannon-street, under the presidency of Mr. John Pender, M.P.

The report of the directors for the six months ended 30th September last stated, *inter alia*, that the Company's revenue for that period amounted to £229,095 5s. 8d., from which was deducted £60,538 3s. 1d. for the ordinary expenses of the Company and £19,140 11s. 8d. for special expenditure during the half year, which, with £3,112 16s. 11d. for income-tax, left a balance of £146,303 14s. From this amount, £38,599 5s. 5d., the interest on debentures and the dividend on the Six per Cent. Preference Shares to the 30th September, together with two interim dividends on the ordinary shares for the quarters ending 30th June and 30th September, 1879, amounting together to £131,024 5s. 5d., had been paid, leaving a balance of £15,279 8s. 7d. to be carried forward. The several sections of the Company's cables continue in good working order.

The Chairman, in opening the proceedings at the hour fixed, said: Gentlemen, the Secretary will read the notice convening the meeting.

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The SECRETARY (Mr. George Draper) having read the notice,

The CHAIRMAN said: The Secretary will now read the minutes of the fourteenth ordinary general meeting.

The SECRETARY having read these minutes,

The CHAIRMAN said: Is it your pleasure that those minutes be signed as correct? Those in favour of that say "aye." To the contrary. Carried. Gentlemen: You have had the report in your hands for some days, and I presume that you will, as usual, take it as read? [Hear, hear, take it as read.] Then, gentlemen, I will just make a few remarks on the figures in the accounts, as I have usually done, so that you may see both sides of the question, the expenditure and the savings which have been effected. The net revenue of the Company for the six months ending the 30th of September last, amount, as you observe, to £229,095 5s. 8d. against, in the corresponding half year of 1878, £207,347 19s. 6d., or an increase of £21,747 6s. 2d. The ordinary expenses of the Company amount to £60,538 3s. 1d. against in the corresponding period of 1878 £56,339 17s. 3d., or an increase of £4,198 5s. 10d. These figures, however, include the cost of working forty-one stations now open against thirty-six in the corresponding period, and also three items which did not appear in 1878, namely, maintenance ships' reserve fund £2,000, depreciation of cable stores £2,105 19s. 4d., and of furniture £100, so that in effect a considerable saving has been made in expenses and a larger revenue secured. The extraordinary expenses amount to £19,140 11s. 8d. as against £20,154 3s. 3d., or a decrease of £1,013 11s. 7d. This item includes the cost of repairs to cables at Vigo and Caminha by the screw steamer John Pender, and repairs to the Suez-Aden cable by the screw steamer Chiltern, and also all expenses of the ships in harbour, &c. It further includes the amount of our contribution towards the expenses of the International Conference—£522 19s. 5d., and £86 for applying the duplex on the Porthcurnow-Vigo section of cable. The full details of our increases and decreases of expenditure I need scarcely go over, but the result is that there is an increase of £75, and a decrease of £629, leaving a net decrease of £554. It think I need not trouble you with the whole of the details of the expenses at the different stations, but the use of patents has been £2,990, as against £2,500, or an increase of £490. This arises from our now having to pay a royalty on relay instruments. These relay instruments have contributed immensely to the more rapid working of our cables, and we consider that the increase is small compared to the great advantages we derive from it. The foreign agencies have cost us £1,125, against £833, being an increase of £292. This is principally agents' expenses on special business to Rome and Constantinople, and the extra cost of Spanish agents. The electrician's retaining fee is the same—£75; the directors' remuneration is £1,850 against £2,000, a decrease of £150, and the auditors' fee is the same as last year, £50. The depreciation of cable stores is set down at £2,105, but there was no such charge in the 1878 half year; the maintenance ships' reserve fund is £2,000, and there was no such charge in the corresponding half year; and the income-tax has been £3,112 against £3,433. I think it is worth stating, in regard to financing up the figures, that we have lost during the year the Egyptian local traffic, worth £4,000 a year; and the Algerian traffic has been suspended for some months. That traffic is worth £4,000 additional, and yet notwithstanding all this our receipts show an increase. I may explain as to the Egyptian system, that for many years we had the working of it. Our concession or lease expired, and the Egyptian Government has since taken it into their own hands. From our experience, however, of the working of the telegraphic system by the Egyptians, I think it is not at all unlikely that we may see that come back; but in the meantime there is no immediate prospect of it. As to the suspension of the Algerian traffic, I may say that we have not been what we may call very fairly treated by the French Government in this matter. We laid down the cables to Algeria; we used those cable lines by extending them to Bona and Malta for our general outward traffic, and they were of considerable use. At the same time, the French Government in the last six months laid their new cable to Algeria, and now charge the same rate from Paris to Algeria as to any other part of France. They are telegraphing to Algeria for half a franc, so it was scarcely worth our while to attempt a competition with them. In that respect the Government of France has not treated us as we think they ought to; but they have made lately an alteration in the management of the telegraphs. They have appointed a telegraph Minister, and I think he has yet to learn something of the nature of the business, and, probably, by and by he will be disposed to treat us more favourably than he has hitherto. We know that "new brooms sweep clean," and probably he would do what he thought was for the best in his department. We shall, however, keep him in view, and when the opportunity comes, and we think he has acquired a better knowledge of the business than he has yet had, I think we may approach him again with some better measure of success. I will now refer to another saving which I think we have effected. We have had to use rather large steamers for doing our repairs in the Mediterranean. We found that a saving might be effected, and we got a small ship, called the Retriever, for repairing the cables, fitting them up, and she has done her work remarkably well. It would suit us better if we had no work to do, but we cannot expect to work these cables without having to do repairs from time to time. The Retriever in the last four months has repaired three cables, she has steamed some 5,000 miles, and altogether we are satisfied that she has done her work remarkably well, and she can be worked at something like half the cost of the larger steamers. I think, if you will indulge me for a time, that this is an occasion on which we may fairly review a little the position of this Eastern Telegraph Company [hear, hear]. The South African cable has just been completed, and it is an event on which I think we may all congratulate ourselves. It is only six months ago, at our general meeting last July, that I brought the question before you, and got your approval to certain resolutions which I then placed before you in order to enable us to take part in that important work. To-day we have to congratulate ourselves on its completion, and, as I have said, I think I may now review a little the past history of this Company, so that the shareholders may fully understand the valuable property which they possess. A glance at the map of our system will show that we have triplicate cables to Malta and Egypt, and duplicate cables to Spain, Portugal, Gibraltar, Aden, and India. From Aden the cable is continued to South Africa, and from India the lines of the Eastern Extension Company bring us into connection with the Straits Settlements, Cochin China, Japan, Java, Australia, and New Zealand. We have also a network of cables in the Mediterranean running from Greece to Tenedos, on to Salonica, and through the Bosphorus to Constantinople, with a cable in the Black Sea to Odessa, and another from Alexandria to Cyprus—indeed, nearly every place of importance in the Levant is connected with one of this Company's cables. The whole mileage and capital is as follows:—The Eastern Company has now a total of 16,331 miles, and a total capital of £5,279,000; the Eastern Extension Company has 9,928 miles, and a capital of £2,957,000; and the South African Company has 3,925 miles, and a capital of £950,000. That makes a gross total of 30,184 miles of submarine cable, and £9,186,500 of capital. The important link now completed, which connects the South African Colonies with our system at Aden—a mileage of about 3,925 miles, and which is to be, for financial reasons, worked under the title of the Eastern and South African Telegraph Company—is the most important connection for length, and, so far as we can now judge, also likely to be for profit. It will be in the recollection of many of the shareholders that the Eastern Telegraph Company as now constituted was formed in 1872 by the amalgamation of the following companies:—The Anglo-Mediterranean, Falmouth, British Indian, and the Marseilles. I may mention that I am giving you this information to-day because there is an impression abroad that our system has been very seriously "watered," but I think I shall be able to show you by figures that we stand in a thoroughly respectable position as regards that question. Well, then, to place the shareholders in these separate undertakings on an equality—for at that time there was a great clamour for amalgamation—a certain number of bonus shares was allotted. The amount of these bonus shares was £957,000, or about 18 per cent. of our gross capital of £5,279,000. Thus the original shareholders, as pioneers of the enterprise, obtained a certain advantage over those buying later, and they are to-day earning about 7½ per cent. We are paying a dividend of 5 per cent., but those who joined the Company at the beginning are actually receiving 7½ per cent. on their money. But inasmuch as our shares stood for a long period at a discount of 30 to 40 per cent., which price gives a return of about 7¾ per cent., a very large proportion of what I would call our later shareholders are in as good, if not rather a better position, than the original pioneers of the Company. The present price of our shares is about 10 per cent. discount, showing that the public begin to realise the improving nature of our property. I have always said at these meetings that we had to satisfy the public that it was really a property that we represent. I have heard sound and very thoughtful men say, "You cannot call it a property, a cable lying at the bottom of the sea," but we have proved, and I think we shall continue to prove that it is a property you can deal with, and effect repairs very much in the same way as repairs might be effected on a railway. Well, now, gentlemen, paying as we do a dividend of 5 per cent., with a growing reserve, which the nature of submarine cables renders necessary, we may reasonably look forward to the time when a larger revenue shall justify the directors in distributing an increased dividend. I think it right to add a few words with regard to our position *vis-a-vis* the mercantile public. The mercantile public have complained a great deal of our rates, but as I have stated before in this room, if we had been receiving the rates which our prospectus showed at the time of the formation of these companies we should now have been paying 30 per cent. to-day instead of 5 per cent., so the mercantile public, through their ingenuity in coding, have, I think got a very great advantage and benefit out of us [hear, hear]. For some years our traffic has been practically stationary. I have had to tell you at meeting after meeting that this arose in a great degree from the depression of trade which has visited not only our own country, but which has prevailed over every part of the world. I have also said that there was no better barometer of trade than the telegraph system, and I am glad to state to you to-day, as you all know, that trade is reviving not only here, but in every part of the globe, and that we are now beginning to rise considerably in the scale of improved and increased traffics [hear, hear]. I may say this—that whereas twelve months ago we were probably earning about 6½ per cent., I believe that this last week we have earned nearly 11½ per cent.

Sir JAMES ANDERSON: That is on the week.

The CHAIRMAN: Yes, on the week. Well, during these bad times, gentlemen, we have not been idle. We have duplicated our system, thereby increasing the security, and making our 5 per cent. to-day a much more valuable security than our 5 per cent. was without the duplication [hear, hear], and in fact I might almost say it makes the 5 per cent a certainty. This rate we have maintained, notwithstanding the increase of our capital. The addition to our receipts has not been caused by any increase in our tariff, and it is a fact that the rates of the Eastern Telegraph system are cheaper than those of any other submarine line in existence [hear, hear]. Therefore you see that we have duplicated our system, and we have maintained a 5 per cent. dividend. While giving that great additional security to our 5 per cent from the duplication of our system, we at the same time have been able to give to the mercantile public a rate lower than that of any other existing telegraph company. We are enabled to do this in great measure from this duplication, and from the fact that we possess a property which we can repair almost at any point. There may be some parts in very deep water where we might have a difficulty, but in nine-tenths of our whole system we could effect repairs just as easily as can be done on any railway system. I think now that I have given you an amount of information which, as shareholders of the Company, it is well that you should have before you. These remarks pretty well embody all that I have to say in regard to the position of the Company, but still I shall make one or two further observations. I have mentioned the position which each of these companies has occupied during the bad times. You have seen the fluctuations which have taken place in almost every railway company, but the only one fluctuation in regard to the telegraph system that you have seen, has been a steady upward movement. That I think is satisfactory, and must be encouraging to us all. Another point I wish to bring before you is this. We have completed this South African system—the Eastern Telegraph Company, and the Telegraph Construction and Maintenance Company have literally completed the whole of that important work. We, the Eastern Company, hold £200,000 of shares in the South African Company; we shall hold them to all time, and we shall hold them because we believe from what we see that this will be a very important and valuable feeder to the Eastern Company's resources. We have also the advantage from this connection in having a considerable increase in traffic over our line from the African system. We had also to take as our portion £200,000 of

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debentures. We have offered those debentures before the cable was completed to our shareholders. They have not all been taken up. A considerable portion—something like £300,000—has been taken up out of £600,000, and the balance is held by the Telegraph Construction Company and ourselves. Such is the improved prospect at the present moment, for the cable gives such satisfactory results that we have got the Telegraph Construction Company to give us the call of those debentures for a very short period, so that we may offer them to our Eastern Company shareholders. I therefore intend to send a circular to our shareholders offering them *pro rata* these debentures. Now I may mention what these debentures are. They are guaranteed as long as the cable works by the Imperial Government, and by the Colonial Governments of the Cape and Natal. Looking at the difficulty of finding investments now, and looking at that as a 5 per cent. debenture, it appears to me—I doubt whether there is a more advantageous or more valuable security in the market at the present moment than those debentures. With these remarks, I beg to move the following resolution:—"That the report and accounts of the directors to the 30th September, 1879, submitted to this meeting be and they are hereby received and adopted."

Sir JAMES ANDERSON: I beg to second that.

The CHAIRMAN: It has been moved by myself, and seconded by Sir James Anderson, that this report and the accounts be adopted, and if any gentleman wishes to make any remark before I put the resolution, I shall be glad to hear him.

Mr. ROBERTS: I see that we have here a certain sum put down as reserve fund, and then there is another fund, standing as other investments, amounting to £37,000. Then there is an item of deposits and loans, £130,000, and cash at bankers' and in hand £38,000. May I ask what the meaning of this is—that you have so much money lying in hand?

The CHAIRMAN: It is on deposit. We are receiving money constantly, and we must keep it on deposit. We had to pay £200,000 on the shares of the South African Company.

Mr. ROBERTS: You had not paid that?

The CHAIRMAN: Not at that date. It has been since paid; but these accounts are only up to the 30th September.

Mr. NEWTON: It think, sir, that the statement you have made as to the value of this Company's property is one that should be known thoroughly, and that it should be placed in the hands of the shareholders. It has long been my opinion that the public have not and do not appreciate the value of this Company's property. The remarks you have made have put before us what the value of this property is becoming, and I think the hundreds of shareholders who do not come to London, living so far away, should have the details before them which you have given us, and that they should read and study them at their own firesides. I am sure that this will be for the benefit of the Company. You have mentioned the length of miles we have, and the number of stations, but I should like you to mention the number of different sections of the lines—that is, distinct cables not connected with each other physically, but for means of traffic. Then, also, if you could tell us the number of distinct systems upon which the traffic goes, independently of breaks on other systems, I think it would be well, showing, I think, that if a break occurred on one section, two, three, or four, still it would make very little difference to our total gross revenue. I think, if that were put clearly, it will be seen that we have the strength of a trust, that we have the strength of a sound property, which, too, can easily be repaired. Could you also give us some information as to the Cyprus revenue—if it has turned out as you expected, and what prospects there are of revenue from that source. While I am on my legs—I should not wish to say anything that could be thought objectionable; but the chairman has pointed out, I think, that we are in sight of a dividend of 6 per cent.; and I think that the revenue that we are now receiving indicates that. It is not like the revenue of a railway company, where the expenditure increases almost as the receipts increase. I think that our expenses should increase with the revenue only fractionally. I would also like to ask whether you can do away by some means with the complaints constantly arising from the merchants of your alteration of words and codes. Knowing something, as I do, of that business, I am able to say that it is very irritating to merchants, who have to go to enormous expense and fearful trouble to alter their codes. I think you could exercise pressure on those gentlemen who fix these things, so that there should be one decision, and let it be permanent as to the number of words and the letters you will adopt.

Mr. FREWER: The last speaker has alluded to the prospect of our having, perhaps, before long an improvement of our dividend. As a very old shareholder—who held shares in the Red Sea Cable Company—I remember the prospectus sent out on that occasion, and the various prospectuses sent out on successive occasions, have held out to the shareholders the promise of a far higher dividend than 5 per cent.

A SHAREHOLDER: Twenty-five per cent.

Mr. FREWER: I am very gratified to hear you say—and I believe that the shareholders will endorse the statement—that every year the security you offer is sounder. You also point out that our shares are going up to par, and if you could hold out a reasonable prospect that on the next occasion you could give us 5½ per cent.—and I think the traffic returns would amply justify it—I am sure the shareholders would receive the announcement with the greatest possible gratification.

Mr. MARCUS: With regard to the South African Telegraph Company, is that company a myth, or is there a South African Telegraph Company?

The CHAIRMAN: Oh, it is not a myth [laughter].

Mr. MARCUS: Are the whole of the shares held by the Eastern Telegraph Company and the Telegraph Construction Company, or is that company to be formed? It appears to me like a company formed, but there are no shareholders.

Mr. BURT: Oh yes there are, and very substantial shareholders.

The CHAIRMAN: Very substantial shareholders.

Mr. HIRST (who was asked to raise his voice) was understood at first to state that though he had attended the meetings pretty frequently he had not spoken before. He then observed: Our dividend is now much more secure than it used to be. Formerly when we had a single line we were subject to all kinds of expenses by the suspension of our business, but now we have put the property on a safe footing, and I may say that our business and our revenue are likely to continue on a very secure principle. The chairman has told us that we are likely to receive 6 per cent. instead of 5——

The CHAIRMAN: Oh, no; you must not jump at conclusions. What I have stated I have stated very plainly and deliberately.

Mr. HIRST: That was the meaning I attached to what you said, but, although I paid the greatest possible attention to every word you said, I did not exactly understand the amount you spoke of. You spoke of an increase, and I concluded at once that that would be 6 per cent. Looking over the accounts I find reasons to believe that such might be the case, and also from the statement of the chairman that our trade is improving; that the trade generally of the country is improving, and, therefore, that our trade is also improving. In addition to that I find between £15,000 and £16,000 is carried to the good after paying these dividends; when these accounts were made up there was a balance of about £15,000. Well, then, I rather fancied with such a balance from the profits of the last half year and the probability of an improvement still, that we might fairly look to 6 per cent., at all events, as the dividend we should receive in future [hear, hear, and "time, time"]. That would be extremely gratifying, and I thought our trade was likely to meet with no interruption. The chairman has told us that our tariff is less than that of any other line—and that being so we are less likely to have any competing lines—and that we are now going on steadily and doing good business throughout our whole system, without interruption. I think that is an important thing, and that it is of very great importance to the public that they should be able to communicate from one part of the world to another at such a very low rate. Taking the report altogether, and the very satisfactory speech of the chairman, I think that we may conclude that this is a satisfactory meeting, and that we may look on our property as on a sound basis as that of any company [hear, hear].

The CHAIRMAN: Mr. Roberts asked the first question, and I think I answered it at the moment—that these accounts are made up to the 30th September last, and I may make this general remark.

Mr. ROBERTS, interposing: Before you reply, may I make a few remarks?

The CHAIRMAN: You have spoken.

Mr. ROBERTS: I have only asked a question, but I have made no remarks. [A voice: "Spoke, spoke."]

The CHAIRMAN: I must conduct the business properly, and you have spoken. As I explained, these accounts are up to the 30th September. Since then we have paid for £200,000 of the South African Company's shares, so that that answers that question. Mr. Newton's questions are the number of different sections. Well, I might read you over the different sections. ["No, no."] I have read you the different stations, which gives you a pretty good idea of the different sections [hear]. There is the European section—including Spain, Portugal, Gibraltar, Malta—but I have mentioned them all. The European, the Egyptian, the Levant, Odessa, Cyprus, Indian, Red Sea, the South African line, but that is worked in alliance with us—I may go over the list in this way: we have the cable from Porthcurnow to Vigo, another from Vigo to Lisbon, another from Lisbon to Gibraltar, another from Gibraltar to Malta, and those are the different sections of the lines.

Mr. NEWTON: My question is——

The CHAIRMAN: I know what you want, but I am not quite prepared to answer the question as Mr. Newton wants. There are people watching closely every section of our line, and you must accept the thing as a whole. I may not tell you that one is earning 20 per cent., and another 5 per cent. I give you the whole, and I think I am protecting your interest in doing so.

Mr. NEWTON: That was not my question, if you will allow me one moment to explain. The Anglo-American Telegraph Company has three lines, so if there are three breakages their revenue ceases; we may have ten breakages before our revenue ceases; while the Brazilian can only have one break and their revenue ceases.

The CHAIRMAN: If you will read the remarks I made in my introductory speech, you will find that I spoke of triplicate and duplicate cables, and I drew the conclusion that our property is more valuable on account of those triplications and duplications, and also for the reason that we could repair almost any section of those cables without any trouble or difficulty. I think that is about as fair an explanation as I can give you. Then the next question was as to the Cyprus revenue. That is paying about 5 per cent., which we consider very encouraging for a start [a voice, "Very"]. As to the complaints of the merchants, I think I have shown you in the remarks I have made that we have tried to meet the merchant almost at every point. I am quite aware that they have gone to very great expense in getting up that system of coding in which they have shown so much ability, to our cost, but at the same time I quite approve of all that ingenuity. I must, however, say this, that if they carry that ingenuity to such an extent that it is going to seriously affect our revenue we must protect ourselves [hear, hear]. We are most anxious to meet the requirements of the merchants. We are trying, and have been for some time, to get such a number of letters brought together as would enable them to form a code of words easily understood and comprehended by our officers, but if they will take so much trouble to make telegraphy so much more difficult than it ought to be, instead of giving us facilities for doing a greater amount of work, it must be done at their cost. I think we must deal fairly as between the merchants, our customers, and you, our shareholders, and we are trying to mete justice as far as we can to all [hear, hear]. As to Mr. Frewer's improvement in the dividend, Mr. Frewer is very modest in his suggestion. He suggests ½ per cent. All I can say is that we shall be just as much pleased to pay it as you will be to receive it if our accounts justify it. But I think it only right to say to you that we ought to have a good reserve fund; and if, as I have told you, we are not to-day declaring any dividend based on the improvement in trade, it is because—and it will be in your recollection that up to the end of September there was very little improvement in trade. When I meet you in July I hope to congratulate you on a very considerable increase. How that is to be dealt with we have shown you to-day. We always take you into our confidence, and we have shown you the position of the Company, and if we and you think it advisable to give you an extra ½ per cent. dividend it will be very gratifying to us to do so; but do not consider this justified by any statement to-day. The accounts will justify themselves, and you have the right to distribute the money as the majority of the shareholders may please. Mr. Marcus has asked a question as to the Cape Company—whether it is a myth. That is a very remarkable transaction altogether. The Eastern Telegraph Company and the Telegraph Construction Company together have made this cable. The Eastern Company took £200,000

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of the shares, as I said, and so many debentures. The debentures will go to the public, and the shares will be kept entirely for the benefit of the Eastern Company's interests. That interest will give the Eastern Company the control of the whole of this South African system, and although, as I have mentioned to you, there are shares to the extent of £200,000 held by the Telegraph Construction Company, my hope is that some fine morning, when things are very bright and encouraging, I may come and ask you to authorise us to buy those £200,000 shares. That, however, is looking forward to something which may occur, but meantime those shares will not be offered to the general public. Now some may ask the reason for that. The reason is that our shares at the present moment are at a discount, and the South African shares are in all probability likely to be at a premium. We cannot, therefore, deal with them at the present moment. I think I have answered Mr. Hirst in the remark I made as to the dividend. Now, gentlemen, I think I have pretty well answered every question and exhausted every point, and I, therefore, ask you to approve of the resolution submitted. To the contrary. Carried unanimously. Continuing, he said: The next pleasing duty I have to perform is to move "That Mr. George Garden Nicol, who now retires, be and is hereby re-elected a director of this Company."

The motion having been seconded,

Mr. ROBERTS said: Before that is put I have a few words to say. I consider that resolution a vote of confidence in the management of the Company. Before I can give a vote of confidence in the management I will just observe that our receipts are decreasing, and that our expenses are increasing [voices: "No, no," "Time, time," "Nonsense," and "That is nothing to do with the motion"]. I say it has; it is a vote of confidence in and out again year after year, as we are doing here. It is a vote of confidence in management which is yearly decreasing our receipts ["Nonsense"], and increasing in its expenses [no, no]. I hold in my hand a document to prove it. It was but three years ago that our receipts——

The CHAIRMAN: Now, gentlemen, I must ask you—I wish to give every gentleman an opportunity of speaking—to vote on this question. We are now discussing the question of the re-election of directors.

Mr. ROBERTS: I say that that is a vote of confidence in the management.

The CHAIRMAN: Then you must confine yourself to the re-election of directors.

Mr. ROBERTS: Before we elect fresh managers into the Company, we ought to know how we stand. In the year——

The CHAIRMAN: I must call you to the question.

Mr. ROBERTS: You were earning in that year (which was not heard) £250,000, and this year the amount is £230,000. [A voice: "The gentleman is out of order."]

The CHAIRMAN: Do you wish to hear Mr. Roberts? [No, no.]

Mr. ROBERTS (continuing): And you paid £25,000 then for salaries, and now £30,000.

The CHAIRMAN: I will now put this resolution. The statement I have made is very clear and encouraging to-day, and I must make this remark about Mr. Roberts. This is the fifteenth meeting. Mr. Roberts is one of the earliest shareholders, I think, of this Company. He must have watched, if he has given attention to anything, the progress, and the satisfactory progress, of this Company, but on no occasion has Mr. Roberts been present that he has not been singing the same song as to the management of this Company. I am quite prepared to meet any amount of criticism if the figures the gentleman is dealing with are given fairly and correctly, but when Mr. Roberts speaks for the purpose of throwing a little dirt on the directors, and also damaging the property of all the shareholders, I think I have a right to call Mr. Roberts to order [hear, hear]. Now, gentlemen, those in favour of the re-election of Mr. Nicol, please hold up their hands. To the contrary. Carried.

Mr. NICOL: I am obliged to you for the compliment you have paid me in selecting me to the Board. Being connected with the commerce of India and China, I can endorse the information which the chairman has given about the growing improvement in the India and China trade, and being satisfied of that and having a confident opinion of it, I am sure I may state that barring accidents beyond control, I believe that, looking to the certainty of a growing traffic in this Company, there is a great and prosperous future before us.

The CHAIRMAN: The next resolution is, "That Lord Alfred Paget, who now retires, be and is hereby re-elected a director of this Company."

Sir JAMES ANDERSON: I have very great pleasure in seconding that.

The CHAIRMAN: Those in favour of that will kindly hold up their hands. To the contrary. Carried.

Lord ALFRED PAGET: I beg to thank you. I have been connected with telegraphy from the very commencement. I was one of those who, with Mr. Lewis Ricardo, thirty years ago I believe, founded the Electric and International Company, which is now merged into all these companies and the system of telegraphy now in vogue.

Auditors were next appointed, and

The CHAIRMAN then said: That is all the business, and I am much obliged to you for your attendance.

A SHAREHOLDER: I beg to move a vote of thanks to the Chairman and Directors.

A SHAREHOLDER: I have much pleasure in seconding that.

The resolution was put and carried.

The CHAIRMAN: Gentlemen, I beg to thank you on behalf of myself and my colleagues, and I can only assure you that we are at all times most anxious to give you the fullest information. We are always glad to invite the most strict and severe criticism, because we believe that the truth will be arrived at better in that way than in any other. I think we may congratulate you, as we do ourselves, that we are in a very satisfactory and progressive position; and I hope by and by we shall be able to show ourselves in such a position that the proprietors may consider this one of the best securities of the day.

The proceedings then terminated.

THE NEW ATLANTIC CABLE.—Paris, Jan. 22.—It is officially announced that the new cable of the Compagnie Francaise du Telegraphe de Paris à New York has been opened for traffic this day.—*Globe*.

TELEGRAPH SHARE LIST.

Companies.	Closing Prices Jan. 21.		Business Done Week Ending Jan. 21. Highest.		Lowest.	
Anglo-American Ordinary	59¼,	60	61⅛		58¾	
Do. "B"	86½,	¾	88		83¾	
Do. "A"	34½,	5	36		34⅜	
Brazilian	7⅞,	8⅛	8		7¼	
Cuba	8½,	9	9		9	
Do. Ten per Cent. Preference	16,	⅛	16⅜		16⅛	
Direct Spanish	1⅜,	2⅛	2⅛		2	
Do. Ten per Cent. Preference	11,	¼	11⅜		11	
Direct United States	10⅞,	11⅛	11⅛		11	
Eastern ex div.	8 13-16,	15-16	9 1-16		8¾	
Do. Six per Cent. Debenture	103,	6	—		—	
Do. Five per Cent. do	102,	5	104¾		104	
Do. Six per Cent. Preference ...x d.	11¾,	⅞	12		11⅝	
Eastern Extension ex div.	8 13-16,	15-16	9		8⅞	
Do. Six per Cent. Deb.	107,	10	—		—	
German Union	8¾,	9¼	9⅛		9	
Globe Telegraph and Trust ...ex div.	5⅛,	⅝	5⅝		5⅛	
Do. Six per Cent. Preference...x d.	11 5-16,	7-16	11⅝		11½	
Great Northern	8⅞	9⅛	9⅛		9	
Indo-European	23,	4	23¾		23¾	
Mediterranean Extension	3¼,	¾	3¾		3¼	
Do. Eight per Cent. Preference	10½,	11	—		—	
Reuter's	10,	11	—		—	
Submarine	232,	7	—		—	
West India and Panama	1½,	⅝	1⅝		1⅛	
Do. Six per Cent. Preference	7⅞,	⅞	7⅞		7 11-16	
Western and Brazilian	6¼,	⅜	6 7-16		5¾	
West. Union Seven per Ct. 1st Mt.	120,	25	—		—	
Do. Six per Cent. Sterling	105,	7	—		—	

TRAFFIC RECEIPTS FOR DECEMBER, 1879.

Companies.	Dec. 1879.	Dec. 1878.	Incrse.	Decrse
Anglo-American Telegraph Company	59,010 estd.	—	—	—
Brazilian Submarine Company	12,624	—	—	—
Cuba Submarine Company	3,000 estd.	3,095	—	95
Direct Spanish Telegraph Company	1,551	940	611	—
Direct United States Telegraph Company	19,670 estd.	—	—	—
Eastern Telegraph Company	45,704	38,467	7,237	—
Eastern Extension Telegraph Company	26,025	22,929	3,096	—
Great Northern Telegraph Company	16,936	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—

ADDRESSES.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

PETER BROTHERHOOD, Engineer, 56 and 53, COMPTON-STREET, GOSWELL-ROAD, E.C.
Specialities—Patent 3-Cylinder Engines (Silver Medal, Paris), as used by Siemens, Gramme, and Wilde for driving Electric Machines.

RANSOMES, SIMS, and HEAD, Orwell Works, IPSWICH.
Specialities—Portable and Stationary Engines, fitted with patent governors, as tried in the electric lighting experiments on the Thames Embankment.

ABBOTT and Co., NEWARK-ON-TRENT.
Specialities—The "Standard Size" Vertical Cross Tube Boilers. Illustrated catalogue, giving every detail of a variety of Boilers, 2s. 6d., post free.

CARBON ELECTRODES COMPANY. Works: 39, COMMERCIAL-ROAD, EAST.
Specialities—Carbon Rods of all sizes for Electric Lighting. Also, Plates and all other Moulded Carbon Goods. List of prices on application.

M. THEILER & SONS, Telegraph Instrument Manufacturers, 86, CANONBURY-ROAD, N. Works: ALWYNE-LANE, N.
Specialities—Morses, Polarised Relays, Saunders' Curb Keys, Type Printers, Recording Sounders, Duplex Apparatus (Theiler's Patent).

HOOPER'S TELEGRAPH and INDIA RUBBER WORKS, MITCHAM and MILLWALL DOCKS.
Contractors for the Manufacture and Laying of Submarine Telegraph and Torpedo Cables. Manufacturers of Hooper's celebrated Insulated Core. Printed reports on application. Offices: 31, LOMBARD STREET, LONDON, E.C.

THE BRITISH ELECTRIC LIGHT COMPANY (Limited), 41, PARLIAMENT-STREET, WESTMINSTER, and 17, WATER-STREET, LIVERPOOL.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

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SLIP

THE CAPE.—Telegraphic communication with the Transvaal is restored.

THE ELECTRIC LIGHT AT THE DOCKS.—Tenders are invited by the London and St. Katherine Docks Company to fit up their docks with the electric light.

ANGLO-AMERICAN TELEGRAPH COMPANY.—The directors of the Anglo-American Telegraph Company (Limited) notify that until further notice the publication of the company's traffic receipts will be suspended.

SHEFFIELD.—In a recent lecture Mr. Norham, Superintendent of the Sheffield Telegraph Department, stated that 40,000 telephones were in daily use in America, whilst only about 800 were in use in England.

TELEPHONIC COMMUNICATION AT LEITH.—Workmen have been employed for some days erecting wires throughout the town for the telephonic exchanges in connection with two companies who have secured offices in Constitution-street and Quality-street.

MAGNETISM OF THE BLOWPIPE FLAME.—It has been found by Mr. W. A. Ross, of Acton, that the blue pyrocone produced by the blowpipe from an ordinary gas burner possesses magnetic polarity, for its point attracts the north pole of a compass, and repels the south pole.

INDIA RUBBER COMPANY.—The directors of the India Rubber, Gutta Percha, and Telegraph Works Company announce that, after placing £25,000 to the reserve, they recommend the payment of a dividend at the rate of 10 per cent. per annum for the past half year, leaving £2,478 to be carried forward.

TELEGRAPH AND TURCOMAN.—Contrary to what might have been expected, the telegraph line between Tchikislar and Teheran, which was completed by the opening of the Tchikislar and Astrabad line of fifty-six miles last October, has remained unmolested by the roving Turcomans and is now in good working order.

QUADRUPLEX.—Dr. Alexander Muirhead, who has been for some months in America re-establishing the Muirhead duplex system on the Direct United States Cable at Torbay, has, after completing this work, turned his attention to testing the Muirhead and Winter quadruplex system on the land-line of the company from Torbay to New York.

ROUMELIAN TELEGRAPHS.—Mr. Scudamore, the director of the Turkish Postal and Telegraph Service, has arrived at Philippopolis to arrange the question of the Roumelian post and telegraphs. Notwithstanding that the International Commission decreed that they should be managed by the Turkish authorities, Aleko Pasha has hitherto refused to consent to this arrangement, under the pretext that the telegraphs have been bought by Roumelia from Russia at great cost.

ATLANTIC CABLES.—As we mentioned in our last issue, the new French cable has at length been opened to the public, and, of course, existing companies have to face the fact of accomplished rivalry. It seems strange that the administration of these companies, consisting as they do of able business men, should not see the advantage of coming to some arrangement. The new cable was not wanted; it will lead to loss. The question to be solved is, to make the loss as small as possible.

CARBONS AND THE ELECTRIC ARC.—*Apropos* of the recent lamp of Edison, Count du Moncel has recalled the French Academy to his researches on vegetable carbons for electric arcs, published in his notice on the Ruhmkorff induction apparatus in 1855. He there remarks that horn carbon electrodes give less brilliant arc than wood ones, and that with cork rendered conducting by immersion in sulphuric acid the light is much more intense than with carbon, while at the same time the cork carbonises itself.

COMPANHIA TELEGRAHPHICA PLATINO BRAZILEIRA.—Holders of shares in this company and in the River Plate and Brazil Telegraph Company are requested to send in their certificates after the 30th inst. for the purpose of receiving in exchange certificates of shares in the English company. The dividend which will be declared in May will be paid upon shares in the English company only, and transferees sending in transfers for registration will be required to sign a form of application and will receive an allotment of shares in the English company.

JABLOCHKOFF'S CANDLE.—There are now 165 Jablochkoff candles employed nightly in this country, namely, fifty on the Thames Embankment, including the ten on Waterloo Bridge; fifty more scattered over four private establishments in London; six at Hatfield, the seat of the Marquis of Salisbury; forty at Aston Lower Ground, Birmingham; thirteen at Messrs. Samuel Brothers, Ludgate-hill, and six in a Dublin warehouse. It may be added that a Spanish vessel, the Cosmos, recently fitted up here for plying on the river Plate, was fitted up with eight Jablochkoff candles.

THE GOVERMMENT AND THE TELEPHONE.—Messrs. David Moseley and Sons, telegraph engineers, of New Brown-street, Manchester, write:—"It may be interesting to the public to be informed that the Postal Telegraph authorities do not intend by the infliction of a tax to interfere with private firms in the erection and use of telephonic lines, whether worked by magnetism or electricity, provided such wire communication be not intended to form part of 'telephonic exchanges.' The steps taken in the Exchequer Division of the High Court of Justice on the 20th inst. will not consequently interfere with or apply in such cases."—*Times.*

WITH characteristic effrontery the correspondent of the *New York Herald* has interviewed M. Dumas, Chancellor of the French Academy; M. Niaudet-Breguet, the able partner in the well-known firm of Breguet and Co., electrical mechanicians, Paris; Mr. W. Crookes, our distinguished chemist; and M. Fontaine, president of the newly-established Syndicat d'Electricité, in order to worm out of them their opinions of the Edison lamp, and telegraph the results to America. These reports are, rightly considered, neither for nor against the new lamp, and in giving a very reserved reception to the pushing reporter these gentlemen have done a service to true science.

A NEW ELECTRIC CANDLE.—A French inventor, M. Perruche, has presented a new description of electric candle to the Paris Academy of Science. The candle consists of three carbons, two being cylindrical and 0·004 metre in diameter, and applied to each other, the third of square section, 0·005 metre inside, and placed in the angle formed by the first two. The cylinders are in pivotted brass holders between brass plates brought together by a spring. The holder of the square carbon is also capable of oscillation, and the carbon is held by a spring in contact with the other while no circuit passes, but when the current begins takes its separate position. It is regulated by an iron lever and electro-magnet in circuit.

ANTWERP DOCKS.—We gather from the Inst. Civil Engineers' "Abstract of Papers" that from the end of 1878 an

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electric light, erected at the entrance of the old docks, has been in regular operation for three to three and a-half hours at every high tide occurring in the night, for facilitating the entrance and exit of vessels. It consists of two lamps—a Siemens and a Serrin—supplied respectively by a Siemens and Halske, and a Gramme electric machine, both driven by a three-cylinder hydraulic engine, identical with those working the five-ton capstans. Either machine takes from 2 to 3 h.-p. to drive it; for safety, 7 h.-p. is reckoned upon for the two together. The consumption of carbon in each lamp is from $1\frac{3}{4}$ to 2 inches per hour; the carbon in the Siemens lamp is $\frac{3}{8}$ inch square, and that in the Serrin $\frac{1}{2}$ inch square or round.

Transatlantic Telegrams.—The *Financier* understands that representatives of the new French Atlantic Cable Company have arrived in London, with a view to submitting to the Anglo-American Telegraph Company the terms of a proposal by which future conflicts may be avoided, and the 3s. per word tariff kept up. A meeting of the board of the latter company will be held in a few days, when the matter will be discussed. It will be remembered that, some time ago, an agreement was sought to be arrived at by the French Company, but the pretensions it embodied were of so exaggerated a kind as to preclude its acceptance. More reasonable counsels are now, it would seem, likely to prevail, and it is therefore probable that the threatened warfare will not take place. In the meantime it is the intention of the Anglo-American Company to put their sixpence a word tariff into operation on the 1st February, if no decision be come to in the interval.

An Excellent Movement.—An institute under the title of "The West Central District Institute for Boy Sorters and Telegraph Messengers," has been opened at the West Central District Post Office in Holborn. The need of such an institute became apparent when it was seen that the telegraph messengers on leaving their duties in the evening were thrown into the streets of London at times when they were exposed to serious temptations of all kinds. Already between fifty and sixty boys have joined the institute, which will be well supplied with books, newspapers, periodicals, and with games of various kinds. It is proposed shortly to form classes for the improvement of the boys in reading, writing, arithmetic, free hand drawing, &c., and when it is borne in mind that the whole of the sorting force of the metropolitan districts is now recruited from the force of boys in each district, it is obvious that the institute offers a wide field for usefulness. The institute has the patronage and support of Mr. Tilley, C.B., the Secretary to the Post Office.

Edison's Light.—Both the question of obtaining good *vacua* and the cost of the cardboard light are proving obstacles to Edison's success in electric lighting. He is reported to have some difficulty in keeping the vacuum of his flasks permanent, but is trying to obviate the defect. Meanwhile the manufacture of more lamps is being stopped. Those newspaper correspondents who glibly talk of his endeavours after a "perfect vacuum" should reflect that no such thing exists, and that the most perfect attainable by the Sprengel pump still leaves myriads of gas particles within the vessel. It remains to be seen whether or not these residual atoms will not exercise a washing and disintegrating action on the carbon loop exposed to them. Apart from the question of durability, there is still the question of cost to be considered; and according to a recent *Standard* telegram Edison cannot produce more than forty-five lights from a 12 horse-power engine—that is, less than four lamps to the horse-power. Now it was his assertion and belief that he could get eight or ten lamp-lights from a single horse-power. If, however, he cannot obtain more than half of this number the cost of his light, and, consequently, its success, must be very disappointing, as it will prove considerably dearer than gas in New York.

Electric Lighting Apparatus.—Some further improvements in electric lighting have been patented by Mr. R. Werdermann, of Princes-street. The upper or larger electrode is secured as hertofore by means of a clamp, but instead of attaching the said clamp to the fixed vertical rod or bar he connects to the clamp an arm, which is placed in a horizontal position, and is pivotted to a sliding piece on the fixed vertical bar in such a manner that it can move upon this pivot as its centre, and therefore the larger or upper electrode, with the horizontal arm, may rise and fall, describing a portion of a circle in its movement. The horizontal arm is carried beyond the vertical rod, and is provided with a screw thread upon a portion of its length, a nut being placed upon this screwed portion to serve as a balance to the larger electrode. By means of this nut the electrode may be balanced as desired, and the nut is to be so adjusted that this electrode will just overbalance it, and descend when not in contact with the point of the smaller or vertical electrode or carbon rod, and as the latter is consumed the larger electrode assists by its gravity in maintaining the proper connection with the smaller one. When the carbon rod is entirely or nearly consumed the upper or larger carbon will have fallen to or nearly to the points of the guides, and the movable vertical rod will also have descended a proportionate distance. He so arranges the length of this rod that when this occurs its lower end will come into contact with a screw in an arm extending from the standard or pillar, and the electric current will therefore be provided with a short circuit—that is to say, it will not travel through the carbons, but through the bifurcated arm of the two-armed lever to the vertical rod; thence through the screw with which the end of this rod is in contact, and thus to the line wire out of the lamp. Some portion of the vertical rod must be insulated. The carbons will thus be cut out of or detached from the circuit automatically, and the other lamps in the circuit will not be affected. M. Napoli described, with illustrative experiments, this new lamp to the Société Française de Physique at the meeting of Dec. 19.

London Night Telegrams.—Serious complaints have recently been made in the *Standard* against the existing lack of telegraphic communication in London during the night. A physician writing from Harley-street states that "On Sunday evening last I had occasion to send an important message—literally speaking, it may have been one of life or death—to Chelsea. At Vere-street Offices the messenger was told that, it being 'eight o'clock,' the office was closed, and that the message must be taken to the Strand. This was done, and there the messenger learned that there were 'no offices' open at Chelsea, and that the message could not be sent 'till the following morning.' This led me to make further inquiries, and I have ascertained that it is impossible, incredible as it may seem, to send a telegram from one part of London to another between the hours of eight at night and eight in the morning, except to the immediate neighbourhood of some four or five principal offices; that such immense districts as Chelsea, Kensington, Regent's Park, or Hampstead are left as completely beyond the reach of telegraphs for twelve out of twenty-four hours as if they did not exist. Nay, more, it is a fact that, with the exception of sixteen stations in all England, and half as many in Scotland and Ireland, the vast system of telegraph

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communication, so far as the general public is concerned, sleeps during more than half the time for which it might be made available. The value of the telegraph system is its speed. Conceive, then, the feeling of waiting for the transmission of an urgent message for twelve hours at the doors of a closed office—an event which happens in thousands of cases daily and nightly. Instances are within my knowledge in which life has been sacrificed by this stoppage of telegraph communication. The Postal authorities have obtained an immense monopoly. The preceding observations are intended to show how they use it. The public, therefore, will watch with the deepest interest the proceedings initiated to-day in the Court of Exchequer, by which it is sought to extend this monopoly, and to prevent the use of the telephone as a means of communication." Several other letters appeared contrasting the English Government system with the American, where, under private companies, a message can be sent at any hour of the night, and important business transacted. These letters, we trust, will lead to increased facilities at home, for the telegraphs are for public convenience, and not for departmental ease or profit.

THE ELECTRIC LIGHT AT THE ST. LAZARE STATION, PARIS.—At the time when the electric light seems destined to play a great part in the lighting of streets, factories, and similar places, it is easy to understand that the railway companies should seriously consider the question of the utilisation of such an agent. The Northern and the Paris-Lyon-Méditerranée Companies first set the example; and now the Western Company has tried an interesting experiment with two of the principal systems of electric lighting, and the new gaslight of the Compagnie Parisienne. The experiments have taken place every evening for some days past in the Salle des Pas Perdus at the St. Lazare Station, and we have remarked with pleasure that the public have followed with much interest the phases of this peaceful contest. Each of the three rivals lights up one-third part of the hall:—1. The Société Générale d'Electricité (Jablochkoff system) employs carbon holders with spherical opal globes, which have long been universally known in Paris; 2. The gas company employs ten improved burners, similar to those used in the Rue du 4 Septembre; 3. The Lontin Society (Lontin, Bertin, and Mersanne) uses four new lamps, which are so adapted as to allow the focus to be placed at any height. The two first systems are already known, the third is less so, although it has been in operation for seven months past at the "Messageries" of the Paris-Lyon Station. This system is essentially dynamo-electric. M. Lontin uses two entirely distinct apparatus; the first serves as generator to the other, which generates any number of currents, according to the number of lamps to be lighted. The description of these two apparatus would require more space than we can spare. Suffice it to say that the production and distribution of the electricity depends upon a double method of division, first by the machines themselves, then by the arrangement of the regulators. These regulators, or lamps, noteworthy for the peculiarity of working easily with any number in the same current, have moroever the advantage of employing carbon pencils of length proportionate to the duration of the lighting, which does away with all manipulation except the daily renewal of this "wick" of the electric lamp. In spite of the considerable loss of light (about 40 per cent.) caused by the use of ground glass globes which enclose the foci, four lamps of the Lontin system are sufficient to light up the space allotted to them. If the globes were suppressed three lamps would serve as well. The Western Company is carefully noting the working of the three systems. Steps will be taken to calculate the expenses of force and money which each one requires. We will publish in a future number the result of the contest.

EDISON'S ELECTRIC LIGHT.—We have been taken to task by several esteemed correspondents for our too sanguine view of Mr. Edison's achievements in perfecting the electric light. We then qualified our statement of "apparent success" by the reported value of Edison Electric Light stock. This week we hear the stock quoted at 1,500 dollars a share, and so rapid a decline would appear to indicate a collapse of some of the claims put forth for the "invention." In order to give our readers and the public some reliable information on the subject, we applied to Mr. Edison himself for some data in support of his assertion that his electric light is cheaper than gas illumination, and we record the following reply from Mr. Edison:—"I wanted to publish the data you refer to, but the Electric Light Company object to it. I may say that I can deliver eight lights net in a house for each indicated horse-power of engine." Since the stock of the company is being bought and sold by the public, we greatly regret the action of the company in withholding information which every stockholder is entitled to, and without which no prudent man should invest in it. Moreover, the objection to giving figures of cost strengthens the position of those who insinuate, if they do not openly assert, that the whole excitement about Mr. Edison's invention was merely for stock-jobbing purposes, partly to bull Electric Light stock and partly to bear gas stocks. This would indicate a very unfortunate outcome after so great a labour, and for Mr. Edison's reputation, as well as for the good of the cause of electric lighting, we trust it is unfounded. Mr. Edison is certainly a very ingenious gentleman, and, while we are not able in the absence of any useful data to say that he has solved any of the great well-known difficulties which have hitherto prevented the realisation of cheaper electric lighting in small lamps, he has, probably, made some important improvements in the details of the plant used for this purpose. The statement that each horse-power will give eight lights, each equal, according to appearance of the lights now at Menlo Park, to a four-foot gas jet is not definite enough to analyse and not favourable enough to be absolutely impossible. The difficulties in the way of subdividing the light, and the great loss of power involved in this, do not yet appear to be solved. When they are, we believe that the secret of cheap electric lighting will be found in the use of cheap water gas burned in small gas-engines in each house, and generating the electricity by means of dynamo-electric machines, for the illumination of one or two houses only. In this way, the loss occasioned by the transmission of electricity to great distances will be avoided, and the little gas-engines can be used for a variety of useful purposes, as well as for electric lighting. It seems also probable that the Sawyer-Mann carbon candle, inclosed in an atmosphere of nitrogen, will be less liable to accident and interruption than the Edison "carbon horse-shoe" in a vacuum. Till it may please the Electric Light Company to furnish a trustworthy, disinterested expert report upon the efficiency and economy of the Edison light, we would give the same advice that we have so often offered in the case of mining property offered here without the report of experts as to its value:—"Wait till the data is furnished, and keep your money till you know what you are getting for it." At the same time, we have a firm faith in the ultimate economic success of the electric light for general use, and we have also a very high opinion of Mr. Edison's ingenuity.—*Engineering and Mining Journal.*

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CORRESPONDENCE.

THE WORD "TELEGRAPH."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to the remarks in last week's *Electrician* on the early employment of the word "telegraph," it may be interesting to some of your readers to know that in an article published in "Nicholson's Journal of Philosophy" for October, 1798, and entitled, "An Essay on the Art of Conveying Secret and Swift Intelligence," by Richard Lovell Edgeworth, Esq., F.R.S. and M.R.I.A., the word "telegraph" is frequently used, and in such a way as to show that it was then a common current term.

The following little extract from the paper will also be read with some interest, as showing what could even then be done in the way of instantaneous transmission of intelligence :—

"In September, 1796, the Lord Lieutenant ordered me to prepare telegraphs for an experiment before His Excellency. In consequence I constructed four new telegraphs. I had found that the large machines, thirty feet high, with which my sons talked, in September, 1794, across the Channel, between Ireland and Scotland, were liable to accidents in stormy weather, &c."—

Yours, &c., EDMUND P. TOY.

Littlehampton, Sussex.

NEW DOMESTIC MOTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have noticed your remarks on the above subject in the last number of your valuable journal, and agree with them entirely. I am happy to be able to say that such want is now supplied, for on last Saturday week I had the opportunity of testing the power of a small motor just completed by Mr. Thomas Slater, the electrician, which I am satisfied will fulfil all requirements as to size, power, simplicity, and cost of working, it being by far the least complicated and freest from a variety of various moving parts and adjuncts of any attempts I have yet seen in this direction. The cost of keeping it in action would not exceed a few pence a day, and I believe it will take its place very quickly as the best and most applicable to the purpose or purposes for such apparatus to fulfil.

No doubt the public will soon hear more about it.—Yours, &c.,

London, Jan. 19, 1880. C. E.

PHYSICAL SOCIETY.

JAN. 24, 1880.—Prof. W. G. Adams in the Chair. New Member, Mr. W. Ellis.

Mr. Grant read a paper and exhibited experiments on "Induction in Telephonic Circuits." He was led to these experiments by a former observation that, when an induction coil primary was placed in a circuit consisting of a telephone, microphone, and battery, the microphonic sounds heard in the telephone were increased on closing the secondary circuit of the coil. Employing a double wound coil, that is, having primary and secondary side by side, he found that the latter could act as a condenser and "relay" or translate messages into a second circuit, the microphone M (Fig. 1) and a battery B being in the circuit of one wire (*i.e.*, the primary), P and the other wire (or secondary S) containing a telephone T. He also inserted a double wound coil W in the latter or secondary circuit S, and caused the induced or translated current to flow through both of the wires, W W', of this double coil, one after another, in the same direction. The effect was weak; but on reversing the current in one half of the double coil by means of a commutator, C, so as to make it double on itself, as it were, the weakening effect of induction was neutralised, and the sounds heard were as loud as if no coil had been inserted in the secondary circuit at all, as was proved by short-circuiting the double coil altogether.

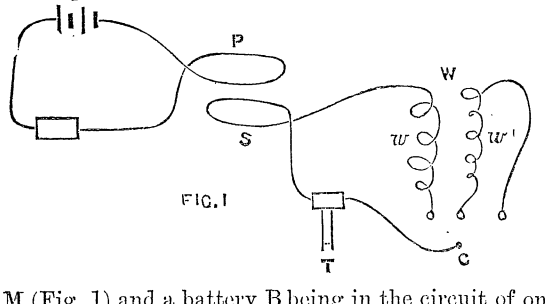

FIG. 1

ON INTERMITTENT CURRENTS AND THE THEORY OF THE INDUCTION BALANCE. By OLIVER J. LODGE, D.Sc.

The telephone, considered as a scientific instrument, seems destined to play an important part as a detector of minute currents of rapidly changing intensity, and the general theory of intermittent currents is being brought into prominence by its use.

The equations to which most attention has been hitherto directed have been those relating to the steady flow of a current after the initial inductive or inertia-like effects have subsided; and in arrangements such as the Wheatstone Bridge, a double key is commonly used in order to allow the introductory stage to subside before any observation is taken. The galvanometer is essentially an instrument for measuring steady currents, or for giving the algebraically integrated expression for the total quantity of electricity which has passed in the case of transient currents.

But the telephone-plate has such a very small period of swing, that the same τ which is vanishing compared with the time of oscillation of a needle may be many times greater than that of the telephone plate. Moreover, the plate is not limited to one mode of vibration, but can have minor vibrations superposed on the fundamental; so that it can enter into the changes going on, and render minute fluctuations audibly apparent which would in more slowly moving detectors be simply merged into the total effect.

The induction-balance furnishes an illustration. The thing itself is old and well known. Dove made experiments with it, and Felici established the laws of current induction by its aid; but its power as an instrument of research was never appreciated till Prof. Hughes applied to it an intermittent current and a telephone.

The general theory of the establishment of a current in a number of circuits of known resistance, in one or all of which a given electromotive force begins to act, was begun by Helmholtz and Thomson, and is, it is needless to say, to be found in Maxwell's "Electricity."

The author proceeds to use this theory in order to work out the theory of the induction-balance and of one or two other cases of intermittent currents as completely as possible, without taking into account the electrostatic capacity of the wires.

The principal cases considered are :—

1. A solitary circuit with a constant (or with a polarisable) electromotive force, but with an oscillating resistance.
2. A solitary circuit with constant resistance, but with a periodic electromotive force.
3. A circuit of const. E.M.F., but varying resistance with another closed circuit in its neighbourhood.
4. The same with the second circuit in some conjugate position and with a third circuit in the neighbourhood of both.

This last is the case of the induction-balance disturbed by a coin. The primary and secondary circuits are arranged in some conjugate position so that they have no effect on each other; this being done practically by splitting each into two equal parts, and arranging the two parts so as to oppose each other; and the third circuit is represented by the piece of metal put near or inside the primary and secondary coils. The primary circuit contains as part of itself a battery and an intermitter; the secondary contains a telephone.

Neglecting electrostatic capacity and leakage (which latter, by the way, must be carefully avoided in a good balance), the current in either primary is the same, and the current in each secondary is the same; not only on the whole, but at every instant of time. In fact, the separation of the two halves of the primary and secondary is immaterial to the theory. The current which is induced in the secondary circuit, and which is heard in the telephone, is a tertiary current produced by induction from the third coil or piece of conducting matter. An expression having been obtained for the strength of the current in the telephone at any instant after a change in the resistance of the primary has occurred, several consequences are deduced from it; more especially concerning the law according to which the disturbance produced by a small coin on the common axis of a pair of coils in an induction-balance depends on its position and size. In concluding his remarks Dr. Lodge observed that he did not know whether it was by the intention of the inventor or by dint of painstaking experiment, but Prof. Hughes had succeeded in hitting upon the best form of balance for his purpose. The paper was a very complete and able exposition of the whole subject.

Herr Faber then exhibited his new speaking machine, which is designed to imitate mechanically the utterances of the human voice by means of artificial organs of articulation, made on the human model, and actuated by an operator, who depresses certain keys, as in playing a musical instrument. These organs are a bellows made of wood and india rubber, which answers to the lungs, a small windmill placed in front of the latter to give the "r" or trilling sounds, a larynx made of a single membrane of hippopotamus hide and india rubber to give

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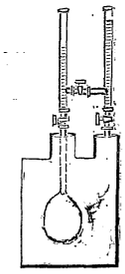
the "drone" or basic tone of the voice, a mouth with two lips, a tongue, and a nose or proboscis made of india rubber tubing placed below the mouth, but curving up towards it. Fourteen distinct vocal sounds can be uttered by the instrument, but in combining these any word in any language can be played by the keys. Thus Herr Faber causes his machine to say such words as "Mariana," "Eliza," "Philadelphia," "Constantinople," and various sentences in French, English, and German, more or less distinctly. Laughing and whispering were also produced, and the voice of the instrument, which was ordinarily loud and clear, and resembling that of a girl, was lowered in pitch and loudness to a more masculine tone.

THE LEYDEN JAR.

Mr. J. E. H. GORDON lectured before a crowded audience on the above subject on the evening of the 19th inst. at the Royal Institution, Finsbury-square. He said that he proposed they should determine some of the properties of the instrument known as the Leyden jar, and see what interest they possessed of themselves, and then that they should try if, from a study of those properties, they could obtain some information as to the way in which electric forces were transmitted from place to place in Nature. If they were in a factory, and saw a steam engine at one end of the room and a lathe at the other, and they found that when the engine started the lathe started, and when the engine stopped the lathe stopped, they would have good grounds for supposing that there was some connecting link between them, and probably they would find a shaft or belt, or some other means of communication. Similarly, in electricity, if they had two bodies, one of which was electrified and the other not, and they found experimentally that with every increase or decrease in electricity in the one there was an increase or decrease in the other, they might suspect some connecting link between the two bodies. The Leyden jar, he then remarked, was discovered in a semi-accidental way in 1746 by a student at the University of Leyden, named Cuneus, who was trying to electrify water. A picture was thrown on the screen of the apparatus used by Cuneus, who was represented as about to touch the wire for the conveyance of the electricity to the water, when he was surprised at receiving such a violent shock that he was said to have stated he would not repeat the experiment for the whole of France. The shock, however, could not have been very violent, although received for the first time it would be sufficiently alarming. Other experimenters were not so timid, and went on investigating the matter. They began by trying to find what property of the water it could be which caused the shock, and very soon they found two things—first, that the vessel of water acted as a kind of reservoir in which quantities of electricity could be stored, that all the electricity which had accumulated had been so stored, and that by being discharged all at once the shock was caused. The second thing they discovered was that the water had very little to do with the matter. In the first instrument they had seen that the two conductors of electricity were the water inside the jar and the hand of the operator outside. The glass was the non-conductor, and did not allow the electricity to pass through it. Leyden jars were now constructed on exactly the same principle, but in a slightly different form. Exhibiting one, he explained that the coatings consisted of two sheets of tin foil. He next charged the jar, and a thin stream of electricity was seen slowly entering, spark after spark going into the jar. This, he explained, was just in the same way as they might suppose the water from a thin stream to run into a reservoir—no very violent effects were caused so long as a thin stream flowed in, but if a sluice were suddenly opened there would be a considerable flow. Thus they saw that the Leyden jar was a reservoir in which large quantities of electricity could be stored up. With a larger and more powerful electric machine he next showed another way of charging the jar, which was slowly filled with as much electricity as would go in, and, as he had previously explained would be the case, immediately the jar became over full, the electricity burst out with great rapidity. The stream of electricity was to all appearance perfectly continuous. That, however, was not the case. It was not a continuous stream, but a series of sparks, instantly emptying the jar when it became over full. This he showed by means of a wheel revolving at high speed. Illuminated by gas, all the spokes appeared to run into each other, the reason for this being, he explained, that gas was a continuous light. If, however, they had a light only at intervals and then going out, the wheel, although revolving, would appear to rest in the position in which it was when the illumination occurred. After demonstrating this, he explained that, notwithstanding appearances to the contrary, the jar acted only as a reservoir, and in no way increased the quantity of electricity. To illustrate this he made a mechanical experiment, a tin vessel being slowly filled by what he asked them to regard as an ordinary stream of water. Immediately the vessel was filled it turned over and discharged itself, of course, with much more effect than when it was being gradually filled. So with the Leyden jar, the increased effect caused by the sudden discharge of the electricity was only due to the successive, gradual storing up of the electricity required to fill it. As to in what way the Leyden jar could act as a reservoir for electricity, he observed that it would not act just as a simple bottle. They could charge outside the jar as well as they could inside. He had constructed a model, intended roughly to represent what happened when the jar was electrically charged. It was found experimentally that when electricity was forced inside the jar it acted in some way or other outside the glass, and exercised a sort of outward pressure upon the outside conductor, and drove away the electricity from it. Whatever quantity of electricity they put inside, an exactly equal quantity was driven out from outside; but there was no communication between the two. He then exhibited a bottle with a bladder inside, and showed a pipe which communicated with the bladder, and another pipe communicating with the outside of the bottle. The bladder was a non-conductor of water, which could not pass through it, but he showed by blowing down the communicating pipe that water was forced into the bladder by the pressure, the water so forced displacing an equal quantity outside. Similarly, in the jar, though no electricity could pass through the glass, there was action of electricity which was equal to the pressure of water in the bladder. In the jar, when the electricity was in a disturbed state, the level was restored.



By opening communication between the inside and the outside of his model, he showed that, although no water passed, the forcing of the water inside the bottle caused a displacement of the water outside, the equilibrium being restored by the flowing of water from one side to the other. So in the jar with electricity. The bottle shape was not the essential form of a Leyden jar. Leyden jars had been made consisting of a flat piece of glass (exhibiting a specimen). The only essential things for the construction of a Leyden jar to make it act as a reservoir of electricity were two—a conductor and something to support it. The insulator must be of some elastic nature—something which would give way to electrical action. He had spoken of electric strain, or pressure, which passed through the glass, and that was not a mere scientific imagination, but a thing which had a real existence, and if the strain were sufficiently strong it would even break the glass. The reason why it did not break the glass of the jar (exhibited) was that the strain was distributed evenly over a very large surface of it. A bridge with a heavy load evenly distributed on it would probably bear it, but if the load were concentrated on one part it might break it. This was illustrated by an ingenious mechanical contrivance with the effects mentioned. In the same manner, although the glass would be able to bear the strain when spread over a large surface, if it were concentrated on one part the glass would probably break. He then pointed to a box, inside of which, he said, was a piece of flat glass nearly an inch thick. There were two wires inside which passed to the glass and stopped inside of it, the whole thing being bedded in cement, and he showed the strength of the electric spark by its power to perforate the glass. [It was shown at the close of the lecture that this experiment had been effectual.] He next exhibited two long aurora tubes, and showed that when one was filled with air there was great resistance, and that the electric spark would only go through the tube a short distance, but that when the air was pumped out they could make the same spark pass through many feet. [In his experiment he made it pass through eleven feet.] He would show them one more analogy between the way in which mechanical and electrical forces were transmitted. If they wished to make a piece of iron yield to some mechanical force, they would make the iron hot, and would thus be able to bend it; and similarly, in the electrical case, he showed, with a piece of quill tubing, that if they made the glass hot it became a conductor, and the spark, instead of passing through the free air, would pass along the tube as a partial conductor. He showed that a charge could be got into the jar whether it were put in from outside or inside, so long as the part where the charge was put in was insulated. Another phenomenon of the Leyden jar was what was called the residual charge. Having charged the jar he discharged it, and, leaving it for a few moments afterwards, it was found that it spontaneously acquired a fresh charge from some source or other. The explanation of this phenomenon was that the glass was strained or distorted. He discharged the jar, took away the straining force, and all the particles of the glass sprang back almost, but not quite, to their original position, remaining for a few moments in a temporary position of rest, and then gradually attaining the original position. This he showed by means of a piece of gutta percha, which was wedged in a piece of wood. The room was darkened, and the illustration was thrown on the screen. He then pulled the gutta percha on one side with his finger, making a curve, which was intended to represent roughly the curve or force of an electric discharge. When the discharge took place, it was represented by letting the gutta percha fly back to its original position, which it was seen it never attained at first, but after a while it gradually recovered its perpendicular position. He had shown them that the residual charge was something like in kind the recovery of a body of mechanical strain; but he hoped to show them that it was not only in kind but in degree, and this through the elaborate experiments of Messrs. Ayrton and Perry. These experiments had not been published, or even read before the Royal Society, so they must be specially grateful to Mr. Ayrton that they were able to show the results. Two curves were then thrown on the screen, one representing the rate at which the residual charge returned, the other the rate at which a beam recovered from a mechanical strain. The curves were not, he explained, necessarily in the same direction, but there was just about the same curvature. An experiment with the electrometer followed, in amplification of the previous one. A spot of light in the form of a circle was thrown on to a scale, and the audience were asked to remember that when it moved slowly along the scale the residual charge was returning slowly, and that when it moved rapidly the residual charge was returning quickly. The Leyden jar was charged and discharged, and the spot was seen to move slowly along the scale. The jar, which was gradually discharging itself, was then tapped with a piece of wood, when the discharge was rapidly accelerated, and the spot of light also moved much more rapidly. Electrical action of one kind or other was constantly being transmitted from the sun to the earth, but what was the medium? They knew in the case of light and heat which were transmitted from the sun to the earth that they were transmitted by vibrations of a sort of fluid, which filled all space, and was called ether. Mr. Gordon concluded his lecture, which was very frequently interrupted by warm applause, by referring to Professor Maxwell's theory, that the same ether which carried the vibrations of light and heat from the sun to us also carried the electric disturbances.

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THE ELECTRICIAN.

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THE POST OFFICE AND THE TELEPHONE.

A striking example of the freedom of newspaper criticism in this country has just been afforded by the outspoken remonstrance with which the Government has been met in its proceedings against the Telephone Companies. This is a healthy sign, and when we see the Press, representing all shades of political opinion, combining to guard what is conceived to be the public interests, there is perhaps little reason to apprehend that they will be seriously invaded. It is manifest that unless the Post Office authorities can make out a better case than was put forward on their behalf the other day in the Court of Exchequer they will have to abandon their claim to exclusive right in the last and most wonderful of telegraphic discoveries. But it is obvious, on the other hand, that the official case was not fully stated—or, rather, that the reasons for proceeding with it were not fully explained. There can, we imagine, be no dispute about the public's right to a beneficial interest in the Telephone; the real point of difference will be to whom shall the public look for the distribution of this benefit. The Post Office claims to have a past, present, and prospective privilege to control all traffic of a telegraphic character within this realm. The Telephone Companies claim to be in possession of a mode of communication not telegraphic in the sense contemplated by the privilege in question; and they have the advantage of standing before us as public benefactors, while their official opponents appear in the character of selfish obstructives. The legal issue will be settled in due course by the proper tribunal, and we do not propose to discuss it here. Our professional knowledge, however, enables us to view the question both as touching the interests of the public as well as the interests of inventors in a more judicial spirit than that adopted by the Daily Press, and we shall give our opinion without reserve.

We are at issue with the newspapers, at starting, on one rather vital point, namely, as to the whereabouts and nature of the interests now under discussion. As a fact the public entrusted them to the hands of the Government, not only to manage but to guard. Nominally there were no conditions except of a pecuniary sort attached to the bargain; but morally, and we may say practically, the Government is bound to supply the public with the very best article obtainable for its money. We say practically, because the public cannot long be denied anything it has a right to and is right in demanding. But here we are met by the further fact that, having yielded its powers to the State, it has, subject only to the condition just referred to, yielded also its private judgment. Of necessity the State must choose its own tools, for this, if for no other reason, that nobody else is empowered to choose them. This may be unfortunate; but it is a fact, and an Act of Parliament only can alter it. When therefore there is any lapse of duty or error in the administration of the Public Telegraphs the only available remedy is to bring public opinion to bear upon it. If for example an action, so to speak, were brought against the Postal Telegraphs for neglecting to provide a Telephonic system for public use, the Department would certainly have its movements accelerated. In all likelihood the formation of at least two Telephone companies has had that effect; for we now learn that a Telephonic appliance has at length been officially adopted. Herein, it may be observed, our Government has only followed at a distance the example set by the Postal and Telegraphic administrators of the German Empire. Whether the public will be satisfied with this solution remains to be proved; but it is evident that the companies will not.

In its generous sympathy with these companies, the Press has we think overlooked or underrated one of the consequences which would result from their success,—namely a heavy deficit at the Post Office. Now if the question resolved itself simply into one of taxpayer against telephone we should unhesitatingly pronounce in favour of the latter. The Telephone has already proved itself to be too valuable a means of communication between all classes of business and professional men to be sacrificed through fear of having to make good a deficit by extra taxation. But does the question so resolve itself? If it does, then indeed the Government will be solely to blame for loss of revenue that might in reality have augmented its own coffers. The exertions of these private ventures have made us familiar with what the telephone is capable of, and the public is being educated to believe in the possibility of "switching" it into vocal communication with almost any point it pleases. Is the Post Office, now that it has made choice of an appliance, prepared to give the public like facilities? If not, then these facilities will be sought and obtained elsewhere; for a monopoly cannot be upheld in law which in practice fails to accomplish the object for which it was created.

If, however, these facilities are promised by the existing

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monopolists, it is extremely probable that the public will, on calmer reflection, sustain them in their legal contention, for the simple reason that it will be to the interests of the taxpayers so to do. The advocacy of public interests is somewhat incomplete and one-sided if it do not take into account the integrity of public property. A loss of business to the Public Telegraphs, which would certainly arise through the unrestricted competition of private systems, would have to be made good out of the public purse; so that the public would in reality be paying twice over for its facilities, one of these payments simply going into pockets of the companies' shareholders. Promoters and Inventors alike deserve to be, and we sincerely trust will be rewarded; but, plainly, a country where monopoly prevails is not the one from which reward can be most confidently looked for. Further, it is one of the interests of the public to appropriate the best and only the best system; and we make no doubt that the authorities will plead that, in fulfilment of the trust reposed in them, they have waited till they could discover the best. This may be only an excuse for dilatoriness; but on the other hand, as the systems are not all good, or at any rate not all equally good, the public will be slow to blame their servants for not recommending the worst instead of the best, or the worst and the best alike.

But it has been contended that the Government accepted its bargain for better for worse, and, like every other business concern, must abide the risk of being beaten out of the market by a superior article. The fallacy here of treating the Government bargain and the public bargain as two distinct interests would probably not have been committed if the writers had possessed any technical knowledge, and could have foreseen, as our readers certainly can, to what extent private enterprise might be carried in this direction. The Telephone itself has not yet run its race; and Telephones are not the only instruments which are or conceivably might be devised for communicating by means of wires. Nor need the wires be short, or the systems "local"; and, unless the Government were to enter upon an unseemly course of "ruinous competition" with all the companies that might and probably would spring up, its private-wire business entirely, and its general traffic largely, must inevitably be sacrificed. In any case public money would be needlessly wasted. A competition of that kind is obviously not to be endured, and if the Government loses its suit it will do well to leave the telephone in undisputed possession of its present owners. Should it succeed however, it will in honour be bound to do all that the companies are prepared to do. We may leave the vexed questions What is a telegraph wire, and What constitutes a telegram to the respective litigants. The public knows what it wants, and might perhaps be persuaded to take it from either party; but to have it provided by both would result in profit to neither, and a positive loss to the country at large.

Telegraph Tariff in Belgium.—The new telegraph tariff which came into force in Belgium at the commencement of the present year has proved so unsatisfactory to the public at large that the Government intend at once to revise it, and will, it is reported, introduce the requisite changes on 1st prox. In future, a simple telegram of ten words, exclusive of the address, which is free, will be charged 50 centimes (5d.), and 10 centimes (1d.) for every additional five words, the charge for figures or numerals being the same as formerly.

STUDIES ON THE ELECTRIC ARC.*

BY JAMES DEWAR, F.R.S.,
Professor of Natural Philosophy in the University of Cambridge.

(CONCLUDED FROM PAGE 117.)

A most interesting fact in connection with these experiments was that the total nitrogen, as estimated by the mercury process was almost identically the same as the nitrogen obtained by a very careful dilution of the acid in a large quantity of water and titration with permanganate of potash, proving that the main product was nitrous anhydride, which may be explained by the fact that the quantity of oxygen in presence of nitrogen in the immediate neighbourhood of the poles is greatly diminished by the combustion of the carbons, or that the nitric peroxide formed is subsequently reduced by contact with the red hot carbon or other reducing products.

FIG 3.

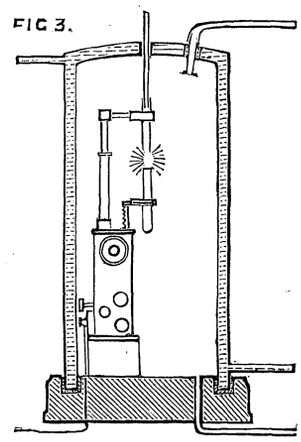
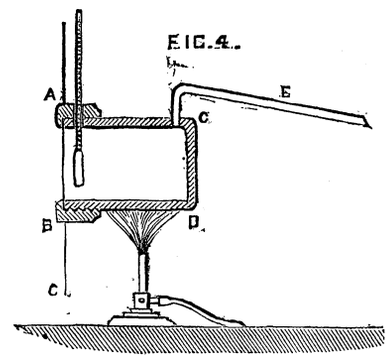


FIG. 4.



In a report to the British Association on the determination of high temperature, in the year 1873, it was shown that the law of Dulong and Petit could not be used for the estimation of high temperatures, seeing that it "gives a far too rapid increase for the total radiation." It was further observed that the curves of intensities of the thermo-electric current obtained from the same substance radiating at different temperatures was a "parabolic curve." Assuming the general accuracy of this law for high temperatures, the total radiation may be taken as nearly proportional to the square of the temperature. From this law the hypothetical temperature of the sun was "estimated as at least 11,000 C." Rosetti has recently made a more elaborate investigation on the subject, and has arrived independently at a formula of a parabolic order. Rosetti represents his results by the equation

$$\mu = aT^2(T-\theta) - b(T-\theta),$$

when μ is the total radiation measured by thermo-electric currents, T° the absolute temperature of the source, the θ° that of the medium surrounding the pile, a and b being constants. However well this formula may represent the complete series of the experiments, it is certain that his results for temperatures above 150° may be expressed within the limits of probable error as proportional to the square of the temperature. To be convinced of this, it is sufficient to plot the logarithm of the respective values of the radiation and temperature, when it will be found the results arrange themselves in a straight line, the tangent of which may be 1·9 or 2 for the observations above 150°. A new set of experiments made with the thermopile, surrounded with an annular vessel, through which a continuous current of water at constant temperature is caused to circulate, as represented in picture, EF representing the section of the vessel, and CD a large water screw, on the same plan, each having a narrow opening, about half an inch in diameter, through which the

* Abstract of a paper presented to the Royal Society.

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radiant heat passed to the pile. The chief points to be noted in the construction of the vessel for holding the mercury or other substance to be heated to different temperatures is the thin texture of the radiating face, which was made of the sheet iron used in the construction of telephone plates. The thermometer must be placed close to the back of the front surface, and the face guarded with a screw, FG. The tube, CE, is connected with a condenser, when substances having a constant boiling point are employed.

This arrangement of the apparatus is necessary in order to get anything like comparable results. The two following tables give the records of two series of experiments, without any correction being made in the numbers representing the deviations of the Thomson galvanometer :—

TABLE I.

Temperature.	Deviation.	Difference.
°		
80	32	6·5
90	38·5	6·0
100	44·5	6·5
110	52	7·5
120	59·5	7·0
130	66·5	9·0
140	75·5	9·5
150	85	10·5
160	95·5	10·5
170	106	11·0
180	117	13·5
190	130·5	13·0
200	143·5	14·5
210	158	14·5
220	172·5	15·5
230	188	

TABLE II.

Temperature.	Deviation.
°	
100	21
150	29
160	46
180	57
200	71
220	86
355	246
440	370

If the differences in the galvanometer readings per every ten degrees in the first tables be tabulated, the second difference must be regarded as constant, so that a parabolic formula can represent the results with sufficient accuracy. These second differences are far more constant than similar numbers deduced from Rosetti's observations, and I am inclined to regard his more complete formula in terms of the absolute temperature as being too complicated, considering the range of the experiments where temperature was accurately known. The results of Table II. extend to the boiling points of mercury and sulphur, and the numbers are in near accord with the simple square of the temperature. The alteration in the condition of the radiating surface at high temperatures causes great complications, and until this difficulty is overcome, experiments with boiling cadmium and zinc must remain uncertain. All the experiments show these to approach a knowledge of temperatures beyond the range of our actual thermometric scale ; the law I gave in 1873 is a sufficiently correct reproduction of the facts from the limited data at our disposal.

The relative intensities of radiation of the positive pole of the Siemens' arc, as compared with the same heated with a large oxy-hydrogen blowpipe, was determined by employing a hollow negative carbon to allow the intensely heated surface to radiate directly on to the pile, as shown in diagram. A large number of observations have been made by this method at different times, and with slight modifications in the order of the experiments. The general result may be stated, that the intensity of the total radiation of the positive pole of the Siemens' arc is ten times that of the same carbon at the temperature of the oxyhydrogen flame. If we take an average result of nine to one, then we may infer that the temperature of the limiting positive pole is about 6,000° C., seeing that the mean temperature of the oxyhydrogen may be taken as 2,000° C.

SOCIETY OF TELEGRAPHIC ENGINEERS.

INAUGURAL ADDRESS.

BY MR. WILLIAM HENRY PREECE, PRESIDENT.

January 28, 1880.

On surveying the wide sea upon which the numerous and varied practical applications of electricity are launched for the subject of this evening's address, I have been puzzled to steer a course that shall avoid the dazzling shoals of theory on the one hand, and the dry hard rocks of practice on the other. Hypothesis is a veritable Scylla that captivates the imagination and often sends the visionary to destruction, while practice alone is a hard-hearted Charybdis that lures the matter-of-fact practical man to folly and expense. Practice must be tempered with theory to utilise advantageously the great forces of nature, and theory itself must be based on practice, or on facts, to be comprehensive and acceptable. Hence success is the offspring of the marriage of practice and theory, and, therefore, as the two are so intimately connected, I have determined to steer a middle course to-night to survey the progress of each in our profession, and to show their mutual relationship.

What is theory? It is an explanation of the hidden cause of certain effects that are evident to the senses. It is an effort of the imagination to account for operations that are in themselves invisible and insensible, but which result in facts that are observable and known. Thus the movements of all those bright bodies by which

> "the floor of heaven
> Is thick inlaid with patines of bright gold,"

are explained by the theory of gravity. Their appearance, vagaries, and beauties are accounted for by the undulatory theory of light. The warmth that the monarch of them all shed upon this earth countless ages ago, and that is now restored to us in our household fires, is explicable on the molecular theory of heat. The constitution of matter and its various states of solid, liquid, and gas, are completely explained by the atomic theory of Democritus and Dalton, and the modern kinetic theory of gases.

It is impossible for a practical man who has devoted more than a quarter of a century to the application of electricity to useful purposes, to avoid devoting much contemplation to the nature of the agent which he has to make use of. The imagination cannot be checked. The mind will dream and theorise. The untutored savage fancies he hears in the roar of the thunder the anger of the Great Spirit, and the tutored Greek saw in the daily course of the sun the chariot wheels of his god Helios, and in the grey dawn of the morning the advent of the soft and gentle Aurora. The Saxon churl saw in the lambent flame of the phosphuretted hydrogen of his marshes the gambolings of Jack o' Lantern, or the treacherous ways of Will o' the Wisp. Is there a member of this society who has not striven to peer into the region of the unknown, who has not speculated on the power he uses, or who has not formed some conception in his mind of the nature of electricity? Yet it is remarkable that the answer to the question, What is electricity? cannot even now be given with authority. Faraday, our great apostle, whose researches should be every electrician's bible, declined to venture an answer, nor did he ever directly formulate his ideas on the subject, though his publications indicate pretty clearly and with no uncertain sound what they were. Clerk-Maxwell, who, while he overthrew all existing theories, failed to supply their place before he was so untimely removed from us. Sir William Thomson, in his published papers, always carefully eschews the consideration of any physical theory of electricity. The French electricians simply use the one-fluid theory as a convenience of language, while the Germans, as a rule, employ the two-fluid theory merely for mathematical purposes. Hence there is no recognised theory of electricity. Some maintain, with Du Fay or with Franklin, that it is a form of matter—a substance ; others, following Faraday and Grove, consider it a form of force—a motion—like heat and light. It must be either one or the other. There is no category in which to class it. If it is not a form of matter it must be a form of force. The question I purpose to discuss is, therefore, Is electricity a form of matter, or is it a form of force?

In discussing such a vexed question it is necessary to be very precise in language to avoid any misconception of my meaning, therefore I will define both matter and force in the sense in which I use those terms. *Matter* is that which can be perceived by the senses, or can be acted upon by force. It is characterised by weight, inertia, and elasticity. *Force* is that which produces, or tends to produce, the motion of matter. It may be pressure, tension, attraction, repulsion, or anything capable of causing alteration in the natural state of rest or of existing motion of matter.

Matter consists of sixty-four known elements which have not yet been decomposed by any known means. There may be other elements that have not yet been discovered by chemists, but they must exist in some known compound. Matter is found in either the solid, liquid, gaseous, or ultra-gaseous state, and it occupies space. It consists of molecules and atoms. The *atom* is the smallest indivisible part of an element, and a group of atoms of the same or of different elements forms the *molecule*, which has a definite magnitude and is unalterable in form for each substance. The *mass* of a substance is the aggregate of the molecules of which it is composed. There is no generation or destruction of atoms. The indestructibility of matter is a fixed law in nature. The size of the molecule is approximately known. Sir William Thomson says :—"If we conceive a sphere of water as large as a pea to be magnified to the size of the earth, each molecule being magnified to the same extent, the magnified structure would be coarser-grained than a heap of small lead shot, but less coarse-grained than a heap of cricket balls." Fifty million molecules ranged in single file would occupy an inch. They are highly elastic, and unless interfered with would move with constant velocity in straight lines. When they can move about freely without interfering with each other's proceedings, we have the ultra-gaseous state of Crookes, a state found only in very high vacua and under certain adventitious circumstances. When they collide and impinge on each other according to the law of the impact of elastic bodies, interfering with each other's path, we have *gases* as we know them ; when their mean free path is so reduced as to bring them within the sphere of mutual attraction, without too narrowly restricting their play, we have *liquids;* when the attraction becomes cohesion and the motion of the molecule is confined to its own sphere, we have *solids*. The number of molecules in a given volume of gas is known, and their velocity calculated. In hydrogen the velocity at 0° cent. is 6,097 feet per second, the number being 10^{23} per cubic inch. The mean free path of a molecule in air at ordinary pressures is the ten-thousandth part of a millimetre. Besides their constant motion in straight lines the molecules may be set in vibration, rotation, or any other kind of relative motion whatever.

This is the atomic theory of matter born in the brain of Democritus, "the laughing philosopher," 2,300 years ago ; preached by Epicurus in Athens, and taught by Lucretius in Rome before the Christian era ; lying dormant for eighteen centuries, until it was formulated by Dalton in the

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last century, and removed from the region of pure speculation by Joule, Clausius, Clerk-Maxwell, and Crookes during our days.

The definition of force shows us that whatever changes or tends to change the motion of matter (or of the molecules of which it is composed), by altering either its direction or its magnitude, is a form of force. Thus gravity is a form of force, for it attracts all matter to the centre of the earth, and it is measured by the rate per second at which a body acquires a velocity in this direction when falling freely at a given spot. Heat is a form of force, for it throws the molecules of matter into violent vibration, or it increases the velocity of their motion in straight lines, which thus becomes the measure of its heat or its *temperature*. Light is a form of force, for it is produced by the undulation of the molecules of matter, and it is transmitted by the undulations of that medium called Ether, which fills all space.

No man has seen or can see a molecule, nor have we any objective idea of what force really is. When we attempt to reach beyond these definitions, we tread upon the threshold of the holy of holies, on whose confines only are we permitted to dwell, and into which we are not yet allowed to enter. "Hitherto shalt thou come but no further, and here shall thy proud waves be stayed." Let us, therefore, be content with precise definitions and clear mental conceptions, speculative though they be, of matter inert and of matter in motion. The *ultima thule* of the scientific man is theory, and at any time his most cherished notions may be

"Melted into air, into thin air."

The scientific man, while rather too fond of decrying the exercise of faith in others, is himself the humblest slave of the imagination. A physical theory may be complete. The various facts and laws which it embraces may be related mathematically with one another, yet one single incompatible phenomenon may dissolve it,

"And, like this insubstantial pageant faded,
Leave not a rack behind."

Hence, while apparently dogmatic in my description of the present theory of matter and force, I wish it distinctly to be understood that it rests, and must continue to rest, on the imaginative power of the mind.

Nevertheless, subjective speculation may become objective reality. Who is there that doubts the existence of the ether filling all space, transmitting those exquisite and delicate vibrations which impart to us the sensation of light and heat from stars and nebulæ countless millions of miles away? And with regard to the atomic structure of matter, though but a speculation as yet, it is so complete, so apt, and so thorough, that for my part, I have not the slightest doubt of its reality, and therefore I submit it with apparent dogmatism.

When we take a given free mass and impress upon it a given force, we throw that mass into motion; for instance, when we fire a loaded cannon, we have imparted to the ball "*energy*," and in virtue of the motion of the ball, this energy is called "*kinetic*." Again, if we lift the ball to a certain height above the earth's surface—say to the top of a tower—and let it remain there, we have again imparted to it "energy," but this time it is called "*potential*," for it is dormant or resting. In each case the energy possessed by the ball is the exact equivalent of the work done upon it, that is, of the force impressed and the distance through which it has acted. The motion of the ball is readily transferred to the motion of the individual molecules of the ball. When, in the first case adduced, the ball strikes the side of a ship or a target, its kinetic energy is thus converted into light and heat, which is molecular motion; or, in the second case, when it is allowed to fall, its potential energy is converted into kinetic energy, which again, on coming in contact with the ground, is converted into molecular motion or heat. Energy is always either potential or kinetic, and one of the most remarkable generalisations of modern days is the grand principle of the conservation of energy, which implies that the total energy of the universe is a quantity which can neither be increased nor diminished, though it may be transformed into any of the forms of which energy is susceptible. Energy is therefore as indestructible as matter. All the recent advances in the science of heat have been due to the discovery of this principle, and its application to electricity has gone far to remove that science from the hypothetical state in which it has existed so long.

My purpose is to contend that electricity is not a form of matter but a form of force, and that all its effects are evident to us in one or other of the several forms of energy characterised by the motions of molecules or of mass.

It is interesting to trace the historical growth of theories. The uncultivated human intellect cannot soar above its own limited sphere of childish observation. Whatever is mysterious and incomprehensible in nature is attributed to that which is equally mysterious and incomprehensible. Life has ever been of this character, and heat, magnetism, electricity, and many other unaccountable physical phenomena, have each in their turn been supposed to be cases of life. Even now there are those who would attribute exceptional and peculiar phenomena to spiritual agencies.

Heat was thought by the Greeks to be an animal that bit. It was then for many centuries thought to be a fluid which, entering into bodies, like mercury, made them swell, and this idea existed until this generation, when Rumford showed it to be a kind of motion, and Joule made it a quantitative form of energy.

Thales, of Miletus, thought that the magnet was endowed with a sort of immaterial spirit, and to possess a species of animation. The Greeks knew also that rubbed amber attracted bits of straw, and supposed it to be endowed with life. Even Boyle, as late as 1675, imagined it to emit a sort of glutinous effluvium which laid hold of small bodies and pulled them towards the excited body. Du Fay in 1733 conceived the double fluid theory, and Franklin in 1747 invented the single fluid theory. Cavendish in 1771 supplied some of the deficiencies of Franklin's theory, but it was Faraday who first exploded the fluid notion and originated the molecular theory of electricity, while Grove boldly classed electricity with light and heat as correlated forces and mere modes of motion.

Light was thought by the Platonists to be the consequence of something emitted from the eye meeting with certain emanations from the surface of things, but no theory of light properly so called was attempted until Newton produced his celebrated corpuscular theory in 1670, which has lasted until the present day. Even as late as 1816 Faraday himself said—"The conclusion that is now generally received appears to be that light consists of minute atoms of matter of an octahedral form, possessing polarity, and varying in size or in velocity."* Although Huyghens in Newton's own time conceived the undulatory theory, the superior authority of the great English philosopher overshadowed the lesser light, and it was not until Young and Fresnel at the commencement of this century took the matter up that the present theory of light took firm root.

Thus we see that all these sciences have passed through the same stages of mystery and fancy, and it is only within the present generation that they have emerged from the mythical to the natural, from mere hypothesis to true theory. *Hypothesis* is an imaginary explanation of the cause of certain phenomena which remains to be shown probable or to be proved true. *Theory* is this supposition when it has been shown to be highly probable and all known facts are in agreement with its truth.

A theory, therefore, to be valid and true, must agree with every observed fact; it must not conflict with natural laws; it must suggest new experience, and it should lead to further developments. A theory is absurd if it supposes an agent to act in a manner unknown in all other cases. The fluid theories of electricity are merely descriptive, they do not agree with every observed fact; they have never prompted the invention of a single new experiment, or led to any development. They suppose an agent unknown in other cases and opposed to natural laws. Incomplete theories die a natural death; thus Descartes' vortices, Newton's corpuscular theory of light, the fluid theory of heat, Stahl's phlogiston, Nature abhorring a vacuum, have all disappeared; while complete theories, such as that of gravity, the laws of motion, the conservation of energy, the undulatory theory of light, not only remain, but suggest new fields of inquiry, open out fresh pastures, carry truth and conviction with them, and have led to the most wonderful predictions. The fluid theories of electricity are certainly incomplete, and they deserve a speedy interment. We have to assume the existence of two substances of opposite qualities which mutually annihilate each other on combination—a self-evident absurdity, for the conception of matter involves indestructibility. Franklin imagined his one fluid to be an element of glass; remove electricity, and glass would lose its virtues and properties, and thus glass was to give out its electricity for ever and a day, without loss of weight or sensible diminution. It was to be devoid of dimensions, inertia, weight, and elasticity, and is therefore outside the pale of our definition.

Electricity is therefore not a form of matter. Hence, according to our reasoning, it must be a form of force.

But can we not prove that it is a form of force? Certainly.

Let us first argue from analogy. We know that sound, heat, and light are modes of motion; in what respects does electricity agree with these forms of force?

The fundamental law of electrostatics is that two bodies charged with opposite electricities attract each other with a force dependent on the square of the distance separating them. Whatever influence or power spreads from a point and expands uniformly through space varies in intensity as the square of the distance for the area over which it is spread increases as the square of the radius. This is the case with gravity, light, sound, and heat, which are known forms of force. It is also the case with electricity and magnetism, which ought therefore to be similar forms of force.

If we regard the velocity of transmission of certain electrical disturbances through space, we have every reason to believe that it is the same as that of radiant heat and light. In 1859 two observers in different parts of the country (Messrs. Carrington and Hodgson) saw simultaneously a bright spot break out on the face of the sun, whose duration was only five minutes. Exactly at this time the magnetic needles at Kew were jerked, and the telegraph wires all over the world were disturbed. Telegraphists were shocked, and an apparatus in Norway was set on fire. Auroras followed, and all the effects of powerful magnetic storms. Moreover, the periods of sun spots, earth currents, and magnetic storms follow the same cycle of about eleven years. Dr. Hopkinson has shown that this electric disturbance through space is as mechanical as its action through short distances, and is, therefore, identical with the ordinary strains of elastic matter subject to distortion by mechanical force. But Clerk-Maxwell has gone beyond this, and has shown that the velocity of light is identical with that of the propagation of electrical disturbances through space as well as through air and other transparent media. Hence, as light is admitted to be a mode of motion identical with radiant heat, electricity must be of the same category.

There is such a remarkable analogy between the conductivity of the different metals for heat and for electricity—indeed, there is every reason to believe that if the metals were pure, the order and ratio of conductivity would be identical—that it is impossible to resist the conclusion that the mode of transmission in each case is the same. Mr. Chandler Roberts, who, using Professor Hughes's beautiful induction balance, showed, by experiments on a comprehensive series of alloys, that the curves indicating the induction-balance effect closely resemble their curves of electrical reistance. He was also able to demonstrate that the induction-balance curve of the copper-tin alloys is almost identical with the curve of the conductivity of heat—a conclusion of much interest; and he pointed out that we might look with confidence to being able to ascertain, by the aid of the induction-balance, whether the relation between the conductivity of heat and electrtcity is really as simple as it has hitherto been supposed to be. Moreover, when a wire conveys a current of electricity it is warmed; as the strength of current is increased, it is heated and eventually rendered incandescent. The ultimate form which every electric current takes is heat. The wire of every telegraph is warmed in proportion to the currents it transmits. Joule showed that when this heat is produced by a current generated in a battery by chemical force, its amount is exactly equivalent to that which would have been evolved by the direct combination of the atoms. The conducting power of all bodies is affected by heat, and some even, like selenium, by light. Hence, as we know that in the case of heat and light conduction is molecular vibration, we reasonably conclude that it is the same with electricity. In fact, it is impossible to account for these phenomena except on the assumption of the motion of the molecules.

The magnificent researches of Dr. Warren de la Rue and Dr. Hugo Müller on the electric discharge with the 11,000 cells of chloride of silver battery that the former philosopher has provided himself with in his celebrated laboratory, have shown indisputably that the discharge in air or in gases under

* "Life," vol. i., page 216.

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various pressures is a function of the molecules filling the space through which the discharge occurs. In fact, the resistance of the discharge between parallel flat surface is as the number of molecules intervening between them; and they show that during electrical discharge in a gas there is a sudden and considerable pressure produced by a projection of the molecules against the sides of the containing vessel distinct from that caused by heat, and unquestionably due to the molecular action of electrification. The long-continued and patient researches which these eminent physicists are carrying out prove beyond doubt that electrical discharge is simply molecular disturbance. In reality, the fact that no discharge occurs through a perfect vacuum is a crucial proof of the molecular theory.

Some recent very remarkable researches of M. Planté with his rheostatic machine* have shown that fine wires conveying powerful currents are wrinkled up into well-defined regular nodes, that these effects are accompanied by a peculiar crackling, and that the wire itself becomes brittle, giving clear indication of the vibratory motion of the molecules. He gives as the result of his enquiry that electrical transmission is the result of a series of very rapid vibrations of the more or less elastic matter which it traverses, and he points out certain analogies between electric motion and sonorous vibrations. This view has been supported by the researches of Professors Ayrton and Perry on the viscosity of dielectrics.†

Professor Challis, of Cambridge, has extended this view so far as to embrace magnetism, electricity, light, heat, and gravity in one category of physical force, and to assert that they all result from motions and pressures of a uniform elastic fluid medium pervading all space not occupied by atoms. His views, however, have not received much attention, for they are not based on the foundation of any new facts, and they are utterly subversive of many cherished principles deeply rooted in the scientific mind. It is to be observed, however, that he regards electricity as a form of force.

Mr. Crookes in his recent beautiful experimental researches into molecular physics in high vacua has still more conclusively proved the connection that exists between electrical action and molecular motion. In fact, his experiments are so brilliant, his expositions so lucid, that one can fancy one sees with the eye of the body that peculiar play of the molecules which can be evident only to the eye of the mind. Not only has Mr. Crookes established as a physical fact the kinetic theory of gases, and the molecular constitution of matter, but he has indicated the existence of a fourth state of matter where the molecules fly about without mutual let or hindrance. He has also led us to doubt the truth of the generally received opinion that an electric current flows from the positive to the negative electrode. It would appear from his investigations that the reverse is the case. Be that as it may, he has added one story to the structure of the molecular theory of electricity.

The criterion of good theory is, however, its power of prediction. A false theory has never led to prevision. Neither the corpuscular theory of light nor the fluid theories of heat and electricity ever led to the prediction of something of which eyes had not seen nor ears heard. The triumphs of prediction in astronomy, sound, light, and heat are innumerable. Faraday predicted the effect of induction in lowering the velocity of currents of electricity and the action of magnetism on a ray of light. Sir William Thomson predicted that a current in passing from a hot to a cold part of a copper bar would heat the point of contact, while in an iron bar it cools it. Peltier predicted the cooling effect of currents on the junctions of thermo-electric pairs.

But the true identity of these physical effects is conclusively shown by their quantitative character and by their adhesion to the law of the conservation of energy. Take the case of the electric light. The consumption of coal in a furnace generates steam, the steam works an engine, the engine rotates a coil of wire in a magnetic field, the motion of the coil in this field induces currents of electricity in the wire, these currents of electricity produce an arc, and thereby heat and light. The energy of the coal is transformed into heat and light through the intermediate agency of electricity. Is it possible to conceive that this intermediate agency is anything but a form of energy? Take the case of the Bell telephone. The energy of the voice produces the energy of sonorous vibration in the air, the vibrations of the air cause the vibrations of the iron disc, the vibrations of the disc vary the magnetism of the magnetic field, this produces currents of electricity in a small coil in this field which vary the magnetism of the distant magnet, which in its turn throws its disc armature into vibration, and thereby repeats at the distant station the sonorous vibrations of the air, and thus reproduces the energy of the voice. A tuning fork comes to rest sooner in front of a telephone than when it is allowed to vibrate freely in air. Here we have the energy of the fork passing through the several stages indicated above, and ultimately coming out in its original form. The energy of sonorous vibrations at the distant station is that lost by the vibrating tuning fork.

Is it possible to assume that in this cycle of changes energy has been transformed into matter and matter again formed into energy? It is impossible and absurd. Clerk-Maxwell said—"When the appearance of one thing is strictly connected with the disappearance of another, so that the amount which exists of the one thing depends on and can be calculated from the amount of the other which has disappeared, we conclude that the one has been formed at the expense of the other, and that they are both forms of the same thing."

Would it be possible to light the streets of New York by the energy of the falling water at Niagara, as has been suggested by our past president, Dr. Siemens, if the cycle of changes from the one spot to the other were not all different forms of this same energy? Would it be possible to plough a field a mile away from the source of motive power of the transmitting medium if the electric currents were not forms of the same power? Electricity in its effects is and must be a form of energy.

The final stage into which any physical theory grows is that in which every action can be expressed in mathematical language, where every phenomenon is calculated upon an absolute physical basis, and where we can foretell exactly what will occur under any possible emergency. This is the present condition of the science of electricity. We can calculate exactly how much steam power is required to generate a given current to produce a given light. We can tell precisely what dimensions of cable are necessary to give a certain number of words per minute on the other side of the globe. If a fault develop itself in a long cable through the gastronomic propensities of a thoughtless young teredo, we can calculate to within a few fathoms the locality of his edacious depredation.

Take, again, the conversion of heat into electricity, and of electricity into heat, of chemism into electricity, and of electricity into chemism—but I am tired of these illustrations. It may suit a Darwin or a Faraday to satiate his pupils with a plethora of illustrations to carry his point, or it may suit an author who is writing a book to exhaust his subject, but the president of a society in his inaugural address must regard the time before him and the patience of his hearers. I have shown that electricity is not a form of matter, and I hope I have now convinced you that it must be a form of force. In its effects which are known to us it must rank as one form of energy in the same category with chemism, with light, and with heat, as a peculiar mode of motion of the molecules of matter.

Clerk-Maxwell,* in his classical work on electricity, has used a somewhat curious argument to show that electricity is not, like heat, a form of energy. He says that energy is produced by the multiplication of "electricity" and "potential," and that it is impossible that electricity and energy should be quantities of the same category, for electricity is only one of the factors of energy, the other factor being "potential." But this does not militate in any way against the force of the argument, for in nature we can no more do so than we can separate heat and temperature. Energy usually appears as the product of two factors, and it is the equivalent of the work done. Thus, *Potential energy* is the product of mass and gravitating acting through a distance. *Kinetic energy* is the product of mass and the half-square of velocity. The energy of fluids is the product of volume and pressure. The energy of heat is made up of heat and temperature, and the energy of electricity is the product of electricity and potential. Hence it is that electricity, *per se*, may be said to be a form of force, while all its effects as known to us are forms of energy. Force alone cannot produce energy; it must be force and something else. Force is the power of producing energy, and it must have something on which to produce it. Hence matter is always present; and thus, though heat, light, and electricity are forms of motion, they are in reality properties of matter from which they are inseparable. They are evident to us through the play of the molecules of matter, and thus are properly called molecular forces.

Our society was established for the general advancement of electrical and telegraphic science, and more particularly for facilitating the exchange of information and ideas among its members. The advancement of physical science is as much our duty as is the furtherance of the art of telegraphy. Complaint has been made that we have devoted ourselves too much to the ventilation of purely concrete matters, while abstract questions have been neglected. There may be some truth in this stricture on our proceedings, and there may even be a cause for it. The council are now seriously considering, not perhaps so much an enlargement of the scope of the society, as an alteration in its title which will prevent any misconception as to its aims and purposes. Though the science of electricity is very advanced, there is still vast room for research, and our widely-scattered members, spread all over the face of the globe, with the most costly and perfect apparatus at their command, have a grand opportunity to further the objects of the society, if they only avail themselves of the means at their disposal. Every science, and especially our science, is the outcome of intelligent observation and careful experiment. There is no science that owes so much to its practical employment for useful purposes. The science itself has grown with the art of telegraphy. Practical difficulties have suggested inquiry, inquiry has prompted trial, trial has opened the eye of the mind to further development, and the result is that the highest scientific authorities acknowledge their indebtedness to the telegraph engineer. The historical inductive philosophy of Bacon is supposed to teach us that to establish science on a true basis we must accumulate a vast array of facts, marshal them in proper methodical order, and extract from them laws. But this is not the natural order, nor is it the method pursued by Newton, Faraday, or any great master of science. Joule has spoken of "a new era in the history of science when the famous philosophical system of Bacon will be to a great extent superseded, and when, instead of arriving at discovery by induction from experiment, we shall obtain our largest accessories of new facts by reasoning deductively from fundamental principles."†

Faraday said:—"I must keep my researches really *experimental* and not let them deserve anywhere the character of *hypothetical imaginations*."‡ Nevertheless all Faraday's researches are characterised by the hand following the brain; by observation and experiment checking, as it were, the speculations of thought. For forty years he pursued his pet notion of the connection between magnetism and light. He was sure it existed, but it took him twenty-three years to prove it.

Jevons said:—"Modern science is not the result of the Baconian philosophy, it is the result of the Newtonian philosophy and the Newton method. The 'Principia' is the true 'Novum Organum.' It is the result of theory guiding experiment and yet wholly relying on experiment for confirmation; the brain guiding the hands."§ In our practice difficulties have suggested remedies, effects have suggested causes, hypothesis has suggested experiment, and experience has confirmed or refuted the hypothetical anticipations of the fertile brain. The difficulties in working underground wires, and in cables, suggested to Faraday and to Thomson those researches which have placed the laws of induction on "the solid ground of nature." The necessities of the telegraph engineer prompted the members of the committee of the British Association to labour with such success as to bring the physical quantities of electrical elements within the fold of exact and absolute measurement. We glory in the present day in the perfection of apparatus which the requirements of telegraphy have evoked, and experiments which Newton would have thought too minute to fall under the observation of our senses are repeated every day. The indications of Thomson's reflecting galvanometer, and the beats of Bell's telephone are only equalled by Whitworth's gauges and by spectrum analysis.

The development of ocean cables has opened a new world to the scientific observer, and Porcupines, Lightnings, and Challengers have probed the deep unfathomed caves of ocean, swept the bed of the mighty deep, and scoured the surface of the seas, to search out new facts, and to open up

* *Comptes Rendus* lxxxix., p. 76-80, 1879.
† *Proc. Roy. Soc.* pp. 7, 8. No. 186. 1878.

* Vol. i., p. 30.
† *Phil. Trans.*, 1858.
‡ "Life of Faraday," vol ii., p. 35.
§ "Principles of Science," vol. ii.

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fresh fields for the naturalist, the biologist, and the meteorologist. There are many questions that remain unanswered, and that offer work for our members. The distribution of atmospheric electricity, the conductivity of the atmosphere, the cause and nature of earth currents, the electrical relation that exists between the sun and the earth, the cause of electrification or polarisation in insulated wires, the various phases of induction, and many other points deserve inquiry, for report to the society for discussion at our meetings, and for record in our proceedings.

Earth currents have been a favourite subject of inquiry of mine for many years. I have always entertained the idea that they are directly due to the action of the sun. Some disturbance in the sun causes, by induction, a variation in the distribution of the lines of potential on the earth's surface, and produces the conditions required for these currents. I have many facts to support this hypothesis, but I want more to confirm it. Professors Ayrton and Perry have developed a theory of terrestrial magnetism based on the assumption that the earth is a highly-electrified sphere, which not only coincides well with facts, but which tends greatly to support my views. I want observers to record the times of daily maxima and minima. I want them especially to note during those periods of unusual disturbance the direction of the circuits which are *not* affected, for they would give the direction of the lines of equipotential. This not only offers a useful field of observation, but its failure or success will illustrate the modern method of scientific research, when the brain suggests to the hand and the eye what they have to do and what they have to look for.

Our society not only offers a useful field for scientific research, but it supplies a very useful arena for the education of its members. We shall shortly have open to their perusal the finest electrical library in the world —that of Ronalds, and we have the hopes in the future of having added to it an equally famous one, collected by one of our most eminent past presidents.

But knowledge gained from books should be confirmed by experience. We are too much apt to rely on illustrations, and think we know all because we can illustrate it by pen or pencil. Many a bright idea is lost for want of an opportunity to test its validity. Those who reason theoretically without demonstrating experimentally are sure to fall into error, while those who experiment in a haphazard way without being guided theoretically, are sure to waste time and money. I want, therefore, to see our library supplemented by a laboratory, where those of our members who have not the means at their disposal, can not only confirm their reading, but go and examine their ideas for themselves by the rigorous test of experiment. We are not all Hughes who can make scientific apparatus out of lucifer boxes and bonnet wire. If the financial abilities of our hon. treasurer prove as successful in the future as they have done in the short career which has distinguished his past occupation of the office I have little doubt that this wish will be within reach of accomplishment.

There is no more useful mode of imparting knowledge than that of lecturing. "It blesseth him that gives and him that takes." The lecturer often learns more than his audience. The possession of a laboratory would enable us to ask those who have made any special line of study their own to favour us occasionally with a *vivâ voce* explanation of their researches and their views. Several societies practise this salutary plan, which is one that was very strongly advocated by Faraday.

Our proceedings form a most useful vehicle for the promulgation of new facts. History tells us of many brilliant experiments and discoveries that have been hidden and neglected from the want of proper publication or of some society to take them up. Thus Mayow, a doctor of Bath, discovered oxygen over one hundred years before it was rediscovered by Priestley and Scheele. Romagnosi, a doctor of Trent, discovered the deflection of the needle fifteen years before Oersted startled all Europe with its rediscovery.

The great cry of to-day is for technical education. Here we have an organisation well suited for furthering this object, and with a home of our own, an unequalled library, and a well equipped laboratory, we ought to be able to stifle the cry, at least as far as telegraphy is concerned.

The science of electricity owes its great development to the vast extension of submarine telegraphy throughout the oceans of the world. The Atlantic has been crossed by no less than nine cables of which three, however, are dumb. A thin cord duplicated the whole way, extends from England to Australia, it is duplexed to India, and one wire extends from Aden to the Cape. There are no less than 97,568 miles of submarine cable now in working order. In spite of the wail of distress that has depressed the commercial world, cable enterprise has not fallen below the average during the past year.

During the past twelve months the Telegraph Construction Company has manufactured 6,800 knots, Siemens Brothers 3,600 knots, the Silvertown Company 900 knots, and Mr. Henley 107 knots of cable—11,407 knots of cable laid by commercial enterprise in all quarters of the globe in one year!

The maintenance of the long mileage of cable requires the employment of a fleet of ships. There are now no less than 27 steamships employed for telegraphic purposes in different parts of the globe. They are all well officered and specially fitted up with machinery and apparatus to facilitate their operations. They are each provided with a skilled staff specially trained to observation and experiment. We are much indebted to Mr. Jamieson for a very interesting paper on Cable Grappling and Lifting, but with this exception we have little or nothing to chronicle of their doings. It is surprising how few are the facts that have been added to our knowledge by such an organisation. It is owing certainly not to want of zeal, but perhaps to an ignorance of what is needed. If they were to study Sir Wyville Thomson's "Depths of the Sea," or his "Voyage of the Challenger," if they were to provide themselves with a good microscope with sample bottles and alcohol, they would be surprised to find how much they would increase their own enjoyment, afford gratification to their friends at home, and further the interests of science. Indeed, ocean life is becoming a source of considerable anxiety to the telegraph engineer, for many little creatures have developed a decided *penchant* for the constituents of which cables are composed. In all the recent cables laid within depths of 100 fathoms by the Telegraph Construction Company a wrapping of thin brass has been externally applied to provide for this growing evil. Damage to the gutta percha has not been observed at greater depths than 100 fathoms, but some specimens of the Atlantic Cable of 1865 which have recently been recovered from a depth of 2,000 fathoms, gave unmistakable evidence of of the destruction of the hemp by some boring animal.

At home, the greatest advances have been made in apparatus. The mileage of wire that has been erected in England to meet the enormous increase of telegraph business that has occurred since 1871 is trifling. The average weekly number of messages in the month of October, for the former year, was 273,000, the greatest number ever reached at that time, while for this last year it amounted to no less a figure than 586,000. This great increase has really been provided for by the improvement in Wheatstone's Automatic Apparatus, by the introduction of duplex working, and more recently by the quadruplex system. The duplex and quadruplex systems have been proved to be applicable to automatic working, and the speed of working long circuits has been much increased by the insertion of intermediate relay stations. But we have reached a limit; our system is actually gorged with messages; failures of wires cause considerable trouble, inconvenience, and complaint, the public—our watchful but not lenient masters are beginning to growl, and the erection of additional wires has become essential. It is hoped that a new trunk line to the North and many additional wires will be erected during the ensuing summer. There is also strong reason to believe that, for the first time since the acquisition of the telegraphs, the balance on the right side will be sufficient to show a surplus over the dividend on the capital expended in the acquisition of telegraphs by the State.

The improvement of apparatus in this country is a veritable case of growth by evolution. The instruments themselves are in a constant state of transition. Every defect or deficiency as it develops itself is removed, and the result is that the instrument grows by a process of careful cultivation and of intelligent selection, prompted by experiment, guided by theory, and confirmed by practice. It is not too much to say that in quality of manufacture, efficiency of performance, and perfection of design, the apparatus of this country takes its position in the very front rank. This applies not only to the apparatus used by the Post Office, but essentially to that employed by the Cable Telegraph Companies. Even lately a very great step forward has been made by Mr. Harwood, of the Eastern Telegraph Company, who has recently much improved the duplex working of cables both as regards speed and efficiency.

The cry that invention has been checked by the monopoly of the Government is made by those who are ignorant of contemporaneous history, who are too callous to inquire for themselves into the truth of the accusation, and with whom most probably the wish is father to the thought.

The telephone—the great excitement of the previous session—has made but little progress during the past year, though there is no doubt that, through the discovery of the principle of the microphone by Professor Hughes, the practical applications of that wonderful instrument have been much improved. In fact, Professor Graham Bell, Mr. Edison, Mr. Elisha Gray, and all those who have been working in this field, have laid aside their own particular form of transmitter, and have adopted one that is a mere form of micorophone. In England we have one or two excellent forms. Those of Mr. Louis Crossley and Mr. Hunnings leave little to be desired, while in America that of Mr. Francis Blake is admirable, and is also much used in England. Litigation has commenced between the Post Office and the telephone companies not to restrict, or in any way to interfere with the use of the telephone, but to prevent the establishment of a particular branch of post office telegraph business without its license or consent.

A curious controversy as to the seat of the vibrations, which result in the reproduction of speech, has occupied the attention of certain physicists on the other side of the Channel. Some following Graham Bell and led by Count du Moncel, attribute the effect solely to what may be called the Page effect, viz., a molecular disturbance of the magnet itself. Others led by Colonel Navez prefer to follow me in a theory I first propounded at Plymouth,* viz., the sonorous vibrations are set up by the mechanical movement of the disc itself. Both theories are really true, and the controversy is, like many other scientific controversies, a war of words. The motion of a mass is the integration of the motions of the molecules of the mass. There is the Page effect in the magnet, and there are the effects of magnetic attraction on the disc, the resultant action being sonorous vibrations. In point of fact, there would be no sonorous vibration if there were no molar motion, and there would be no molar motion if there were were no molecular disturbance.

The electric light has been making considerable progress, and is gradually forcing itself into practical use, in spite of many of the drawbacks to its employment that have yet to be removed. The lamp of the future has not yet been produced, though steadiness and duration have very much advanced during the past twelve months. There is very little room for improvement in the generating machine, for both the Siemens and Gramme machines convert about 90 per cent. of the energy thrown into them into electric currents, and this is a duty which no other kind of machine can show.

One of its most notable and useful applications has been on board ship, to further the operations during the night in laying and repairing cables. I was present on board the ss. Dacia, in the Mediterranean, when this was done, and the success was unequivocal.

The Brush machine has recently been introduced into this country, and its performances are certainly very wonderful. It produces an electromotive force of over 800 volts, and I have seen it maintain 20 very steady arcs joined in series. Sixteen appear to be its efficient limit, and this number of lamps, giving over 1,000 candle power, are easily maintained by an expenditure of 13½ horse-power. The performances of the Brush light are certainly the most advanced form the electric light has yet taken. There are over eight hundred of these lights in the United States; and it is worthy of notice that it has quietly crept into existence without the aid of the ubiquitous and omniscient newspaper correspondent, or the transmission of any sensational telegrams, to the detriment and discomfort of gas shareholders.

It is assumed by many that the electric light is devoid of heat, but Professor Dewar has shown that a Siemens arc radiates heat equivalent to 3 horse-power per minute. Moreover, the use of such powerful currents, unless carefully directed, are dangerous to life and limb, and may even, unless properly protected, result in fire.

Gas is not going to be affected by the electric light. The proper function of gas is to generate heat. Ninety-four per cent. of the ingredients of gas are consumed in generating heat, and only 6 per cent. in producing light. It is remarkable that so amenable and tractable an agent for heating purposes has not been more utilised, but the fact is that the public is ignorant of its properties, careless of its employment, and callous of its defects.

* British Association Meeting, 1877.

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It is not too much to say that fifty per cent. of the gas manufactured is absolutely wasted for illuminating purposes by the wild extravagance with which it is burnt, and by the want of those systems of regulation which have been introduced to compensate for irregularities and excesses of pressure.

The utilisation of the illimitable wasted energy on the earth's surface offers a fine field for the ingenuity of the electrician. The tides of the ocean, the motion of the atmosphere, the rapids of a river, the innumerable waterfalls that are found in every mountainous or hilly country could be compelled to give up in the form of electric currents that energy which gives them existence, and which could thus be employed for providing power, generating heat, or supplying light, away altogether from their source of conversion. In fact, Sir William Armstrong, near Newcastle, and an enterprising hotel proprietor in Switzerland have already produced light in their houses by converting into that form the energy of a neighbouring waterfall.

I cannot omit mentioning the researches of Professor Hughes. Here we have the case of a telegraphic engineer who has spent the best part of his life in improving the working of telegraphs, resting from his labours with well-lined purse, and turning philosopher. Spurning the costly apparatus of the philosophical instrument maker, he takes the simplest and cheapest materials he can lay his hands on, and with fine inventive skill, aided by an instinctive mechanical turn of mind and well-trained hand, he forces nature to develop unexpected secrets, and he enables the chemist of the mint to detect an infinitesimal trace of impurity in the bright golden sovereign. Moreover, he has not only detected an absolute zero in nature, but he has given the physician a standard by which he can measure the relative sensitivity of the dullest and sharpest ears. His induction balance and audiometer are fit sequels to his microphone, and I venture to predict that he will yet wring out of Dame Nature some other facts that have lain dormant since the first fiat went forth, "Let there be light." His mode of investigation is a very apt illustration of the practice I have previously described as so successful in modern scientific discovery of making experiment subservient to hypothesis with the view of furthering science. His investigations have been made without the slightest idea of gaining filthy lucre or of taking by a flank movement some successful inventor's patent—practices which, I am sorry to say, in these immoral times are far too frequent to be palatable.

We cannot but congratulate ourselves upon the position of our society. Our first president, Dr. Siemens, in the first paragraph of his inaugural address, remarked that, "Some years must necessarily elapse before our society can have given substantial proof of its useful action." I venture to submit that those years have passed. Our success has exceeded the most sanguine expectations. Our work has been thought of sufficient importance to merit special reference in the first annual address of the gifted and able President of the Royal Society. The good that our society has done and is doing is patent to all. It stimulates thought, it encourages experience, it furthers the science, and it develops the art of telegraphy. It inculcates knowledge, and is therefore educational; it records results, and is therefore historical; it cements friendship and promotes good fellowship, and it has therefore a moral influence; but, above all, it knits together in one family bond that great wide-spread brotherhood who are found scattered in every quarter of the world, maintaining and operating "the wonder-working wire," to the annihilation of space and the economy of time.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).

A special general meeting of the shareholders of this Company was held on the 22nd inst. at the City Terminus Hotel under the presidency of Sir E. W. Watkin, M.P., "for the purpose of varying the borrowing powers conferred on the directors to the extent of £250,000, and to create and issue debentures to a further amount not exceeding £250,000."

The MANAGER (Major Wood) having read the advertisement calling the meeting,

The CHAIRMAN said he explained at some length at the last meeting—reported in *The Electrician*—the reasons why the plan for the redemption of their debentures, which he had proposed, should be varied in deference to what was regarded as better by many. He told them that the question of the adoption of the better plan had been settled in principle, and that he had no reason to expect that it would break down in detail. The detail of that plan was referred to Mr. Mendel, the deputy chairman, Mr. Cooke, and the members of the finance committee. They had been devoting themselves to the settlement of the question, and had reported to him that they expected payment on account within a very few days, and that they might consider the matter settled, subject to their passing that day the necessary resolution which the solicitor had prepared. He had, therefore, to propose "That the borrowing powers conferred by the extraordinary general meeting held on the 22nd of December, 1879, be varied, and that in addition to the sum of £250,000 which the directors are empowered to borrow under the 17th article of association, the directors be authorised to create and issue debentures to the further amount of £250,000 for the purpose of providing for the redemption of the whole or any portion of the A, B, and C debentures of the Company and for the general purposes of the Company," the debentures to be issued in such amounts and at such periods as the directors might think fit.

The resolution, briefly, meant this—to give the directors power to borrow a sum of £250,000 on debentures. This was no increase of the £500,000, their authorised borrowing powers—it was a simple variation of those powers. The effect of this would be that they would not only be able to pay off the three classes of debentures, two of which would fall on them in August, and repair their cable and pay off their debts, but also give them a margin which could be used hereafter of about £50,000.

Mr. S. MENDEL seconded the motion.

In reply to a Shareholder,

The CHAIRMAN said they had £303,000 in debentures of all kinds, and two classes would fall due in August next. Then they had debts to the amount of about of £50,000 or £55,000. That made about £358,000 or £360,000, and then they required £40,000 to provide for the new cable. That made £400,000. Then there were C debentures which had to be drawn. The £40,000 would not give them a cable from end to end. It would provide 400 miles of cable, which was thought enough. It was to be borne in mind that they had renewed 800 miles of cable already.

The resolution was then put and carried, and

The CHAIRMAN said he might mention that they had had proxies sent to them in support of these proceedings to the extent of a large majority of the capital.

On the motion of Mr. BURT a vote of thanks was passed to the Chairman, and the meeting then separated.

TELEGRAPH SHARE LIST.

Companies.	Closing Prices Jan. 28.		Business Done Week Ending Jan. 28. Highest.		Lowest.	
Anglo-American Ordinary	60¾,	1¼	60¾		56½	
Do. "B"	87¼,	¾	86¾		83	
Do. "A"	35½,	6	35¾		31¾	
Brazilian	7 13-16,	15-16	8		7 13-16	
Cuba	8¾,	9¼	9		9	
Do. Ten per Cent. Preference	16½,	17	—		—	
Direct Spanish	1¾,	2¼	2⅛		2⅛	
Do. Ten per Cent. Preference	11,	½	11⅜		11⅜	
Direct United States	11½,	¾	11¼		10⅜	
Eastern	8 13-16,	15-16	9		8 13-16	
Do. Six per Cent. Debenture	103,	6	105		105	
Do. Five per Cent. do	102,	5	—		—	
Do. Six per Cent. Preference	11¾,	⅜	12		11¾	
Eastern Extension	8 13-16,	15-16	8 15-16		8 13-16	
Do. Six per Cent. Deb.	107,	10	109		109	
German Union	8½,	9	9½		8¾	
Globe Telegraph and Trust	5½,	⅝	5⅝		5¼	
Do. Six per Cent. Preference	11⅜,	⅝	11½		11¼	
Great Northern	9	¼	9 3-16		9	
Indo-European	23,	4	—		—	
Mediterranean Extension	3,	⅜	—		—	
Do. Eight per Cent. Preference	10½,	11	—		—	
Reuter's	10,	11	—		—	
Submarine	230,	38	—		—	
West India and Panama	1 7-16,	9-16	1 9-16		1 7-16	
Do. Six per Cent. Preference	7½,	¾	7¾		7⅝	
Western and Brazilian	6⅝,	⅞	6 11-16		6½	
West. Union Seven per Ct. 1st Mt.	120,	5	—		—	
Do. Six per Cent. Sterling	105,	7	—		—	

TRAFFIC RECEIPTS FOR DECEMBER, 1879.

Companies.	Dec. 1879.	Dec. 1878.	Incrse.	Decrse
Anglo-American Telegraph Company	59,010 estd.	—	—	—
Brazilian Submarine Company	12,624	—	—	—
Cuba Submarine Company	3,000 estd.	3,095	—	95
Direct Spanish Telegraph Company	1,551	940	611	—
Direct United States Telegraph Company	19,670 estd.	—	—	—
Eastern Telegraph Company	45,704	38,467	7,237	—
Eastern Extension Telegraph Company	26,025	22,929	3,096	—
Great Northern Telegraph Company	16,936	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—

ADDRESSES.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

PETER BROTHERHOOD, Engineer, 56 and 53, COMPTON-STREET, GOSWELL-ROAD, E.C.
Specialities—Patent 3-Cylinder Engines (Silver Medal, Paris), as used by Siemens, Gramme, and Wilde for driving Electric Machines.

RANSOMES, SIMS, and HEAD, Orwell Works, IPSWICH.
Specialities—Portable and Stationary Engines, fitted with patent governors, as tried in the electric lighting experiments on the Thames Embankment.

ABBOTT and Co., NEWARK-ON-TRENT.
Specialities—The "Standard Size" Vertical Cross Tube Boilers. Illustrated catalogue, giving every detail of a variety of Boilers, 2s. 6d., post free.

CARBON ELECTRODES COMPANY. Works: 39, COMMERCIAL-ROAD, EAST.
Specialities—Carbon Rods of all sizes for Electric Lighting. Also, Plates and all other Moulded Carbon Goods. List of prices on application.

M. THEILER & SONS, Telegraph Instrument Manufacturers, 86, CANONBURY-ROAD, N. Works: ALWYNE-LANE, N.
Specialities—Morses, Polarised Relays, Saunders' Curb Keys, Type Printers, Recording Sounders, Duplex Apparatus (Theiler's Patent).

HOOPER'S TELEGRAPH and INDIA RUBBER WORKS, MITCHAM and MILLWALL DOCKS.
Contractors for the Manufacture and Laying of Submarine Telegraph and Torpedo Cables. Manufacturers of Hooper's celebrated Insulated Core. Printed reports on application. Offices: 31, LOMBARD STREET, LONDON, E.C.

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SLIP

A Sound Investment—a telephone line.

The Electric Light in Persia.—M. F. Boital has recently introduced the electric light into Teheran, and exhibited it before the Shah. The Jablochkoff candle was used.

Long-distance Telephoning.—A recent trial of Bell's telephone between Dayton, Ohio, and Indianopolis, Indiana, proved that it is quite suitable for talking distances under 100 miles in the United States.

Galvani.—There is a capital engraving of the new Bolognese statue to the famous electrician in *La Nature* for Jan. 24. He is represented as intently studying a frog spread out on a tablet before him.

The Government and the Telephones.—A correspondent has written to *The Times*, pointing out that in America the telephone exchanges help the telegraph companies by connecting up villages to their systems which would not be able to support a regular telegraph office.

Earth Currents.—Cappanera notices that earth currents are strongest in certain volcanic districts. At Potenza they are strongest in the neighbourhood of the volcanic terrace of Vultures, and are most noticeable in October, November, December, March, and April, especially during heavy falls of snow.

Carbons for Electric Lights.—The great importance of getting good carbons for electric lamps is practically demonstrated in a triumphant manner by the Brush light. There the regulating mechanism of the lamp is the simplest in vogue, yet the light is the steadiest and whitest, all because the carbons are excellent.

The Telephone in Wheatstone's Balance.—Herr Niemöller employs a telephone instead of a galvanometer in the bridge wire when measuring the resistance of liquids, with a gain in delicacy. An induction current is used, and it is found that when the galvanometer gives no deflection the telephone gives a distinct sound.

The Electric Light and Shipbuilding.—Messrs. Robert Napier and Sons, Glasgow, have adopted the electric light in early morning and late evening to the building of the new steel mail steamer, Parisian, and the new Admiralty store ship. We may add here that the new rival of the Great Eastern now being built by the Inman Line will be fitted up with the electric light.

The Cuba Submarine Telegraph Company (Limited).—The number of messages passing over the lines of the Cuba Submarine Telegraph Company (Limited) during the month of January was 2,891, estimated to produce £3,200, against 2,687 messages, producing £3,043 in the corresponding month of last year. The traffic receipts for the month of November, estimated at £3,000, realised £3,110.

The Induction Balance and Prospecting.—Professor Hughes writes to us that he is of opinion that the Induction Balance might be found useful, under certain circumstances, for divining the presence of the native metals, gold, copper, silver, &c., under the surface of the ground, as suggested by our correspondent "J.M." The matter can only be put to the proof by trial. Pieces of ore placed in the balance would also speak of native metal.

The Quadrant Electrometer.—Herr Edelmann has supplanted the flat needle in Thomson's quadrant electrometer by one formed of two quadrants cut vertically from a cylinder. This needle thus resembles two of the hollow quadrants which enclose it. The replenisher and static charge of the old instrument is dispensed with in favour of a Zamboni dry pile. We should not like to suggest this "improvement" to Sir William; as a painful want of appreciation might probably be manifested.

Electric Light at Flour Mills.—The British Electric Light Company, of 41, Parliament-street, London, have fitted up the electric light over a considerable portion of the premises of the North Shore Flour and Rice Mills, Liverpool, and with such satisfactory results that we understand that it is contemplated to supply this mode of lighting through the whole mills in the place of gas. The clearness and efficiency of the light, it is said, allow of the value of samples of grain to be judged without difficulty on the darkest day.

A German Electrical Society.—France has now its *Syndicate d'Electricité*, and Germany has just achieved the formation of a technical electrical corporation, which has for its object the development of pure electrical science, the promotion of its application to the arts, and, lastly, the establishment of a place of meeting for German electricians. There are now at least six electrical societies in existence, including the above, our Society of Telegraph Engineers, the Melbourne Electrical Society, the Chicago Electrical Society, and one in New York.

The Eastern Extension Australasia and China Telegraph Company (Limited).—The Eastern Extension Telegraph Company announce the completion of their duplicate cable to Australia, for which the Governments of Victoria and New South Wales contracted in May last to pay to the Company an annual subsidy of £32,400. The new cable is laid direct from Singapore to Banjoewangie, thus avoiding the transit of telegrams through the Island of Java. A continuous day and night service has also been established throughout the whole line to Australia.

Surgery by Electric Light.—Dr. Berkeley Hill recently performed a successful operation for vesica-vaginal fistula, at University College, by aid of a Trouvé incandescent platinum wire polyscope, made by Mr. Coxeter, after a pattern of his own, in which the incandescent wire is twisted into a small knot, and enclosed in a glass chamber, under a second glass cover. Water is circulated between these glasses to keep down the heat. The vagina was lighted by this apparatus for over an hour, during a foggy afternoon, without impeding the actions of the operator.

Launch of a new Telegraph Steamer.—On Saturday, the 24th inst., there was launched from the yard of Messrs. James Laing, at Sunderland, a new steamer for the West India and Panama Telegraph Company (Limited), London. The Grappler, ss., measures 200 feet in length, by 29 feet beam, by 16 feet depth of hold, and has been specially constructed for cable work. The vessel carries large tanks, has ample coiling space, and will receive her picking up and paying out gear in London. The Grappler is now at Messrs. R. and W. Hawthorn's receiving her engines. The work is being carried out from the plans and specifications of W. R. M'Kaig and J. Carlton Stitt, consulting engineers to the Company.

An Electric Log.—A log for registering the speed of ships by means of electricity is no new invention. There has been one patented in England for many years; but it is

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interesting to hear that M. Fleuriais has succeeded in getting one adopted on board the French frigate La Magicienne. It consists of a small turbine of bronze rotating round an axis, carried by a bronze fork, presenting little resistance to the water. The fork is attached to the log line, one strand of which is removed to admit a gutta percha covered military cable of seven wires. The ship's sheathing is used as "earth" in an electric bell circuit, which is closed at each turn of the mill or turbine. The velocity of the ship is got by counting the number of chimes in a given time, measured by a sand-glass.

THE POST OFFICE AND THE TELEPHONE.—The *Western Morning News* states that an arrangement has been entered into between the Post Office and Bell's Telephone Company, by which not only proceedings against the company will be abandoned, but the Postmaster-General undertakes to give every facility for the extension of telephone communication. The Telephone Company will pay a royalty to the Post Office, and may use post offices and staffs under certain conditions for their work. Thus telephone wires may be run from a post office to the town offices or country residences of gentlemen, and telegrams arriving at post offices for them may be immediately communicated by telephone, thus saving time. To country gentlemen, whose residences are at a distance from the nearest telegraph offices, this accommodation will be invaluable.

THE LIQUID VOLTAIC ARC.—A very brilliant and steady, but somewhat unmanageable, electric light is that produced by the liquid voltaic arc which was recently discovered by Mr. C. Boys. It is made by inserting a fused bead of oxide of iron in a liquid state between two platinum electrodes connected to the poles of a 10 or 12 cell Grove battery. The glowing drop or globule heated by the current emits a beautiful golden light, which is quite steady so long as the continuity of the drop is preserved. The addition of a little glass to tincture the drop and form a silicate of iron gives a more powerful light by increasing its resistance and strength, and allowing of a wider arc. Carbon electrodes are not "wetted" by the drop, and platinum ones have to be resorted to. The spectrum of the bead is a continuons one, crossed by dark lines like that of the sun, a fact which is probably due to an absorbent atmosphere of sodium surrounding the globule. It would be interesting to know if the salt is electrolysed.

DANGER FROM THE ELECTRIC LIGHT.—The London correspondent of the *Manchester Guardian* says:—"The electric light is not without its dangers. Some time ago a red-hot morsel of carbon dropped from one of the lamps at the British Museum on to a table usually occupied by readers. It happened that the table was vacant at the moment, and no worse result followed than a slight hole burnt in a blotting pad. Measures were at once taken to prevent the recurrence of such an accident, but not with complete success, for a few days since a similar piece of red-hot carbon fell from the centre lamp to the table of the superintendent of the reading room upon a piece of loose paper, which began to kindle into flame. This, however, as a matter of course, was speedily extinguished. It is conceivable that a single spark might do irretrievable damage to some unique manuscript or other priceless example of literary production, and the authorities are evidently alive to the importance of making this most valuable light not only relatively but absolutely safe. Large transparent glass or talc saucers have been suspended below each lamp, so as to intercept any stray piece of carbon which may happen to fall in the future. It is even proposed to try the experiment of lighting the room from outside, in which case the glass of the central part of the dome would offer a most effectual protection."

TELEGRAPH WIRES IN NEW YORK.—A scheme for underground telegraphs in the American metropolis has been devised by Mr. R. D. Radcliffe, who has drawn a complete telegraphic chart of the city, showing the location of every telegraph instrument, whether belonging to the Western Union, Atlantic and Pacific, Gold and Stock, Police, Fire, Bell Telephonic, or American District Companies. His new plan is to consolidate these lines, and to have three subterranean trunk lines running north and south through Third, Ninth, and Sixth Avenues, with branch lines east and west on poles. He does not advocate laying these branch lines underground unless there are more than twenty of them in the same street, and he does not advocate laying telephone wires underground, for these lines are liable to change of place. He finds that on his plan, instead of 9,000 or 10,000 poles now standing, some 1,500 or 1,600 poles will serve for the purpose. There are 1,148 miles of Western Union wires in the city, 291 miles of Atlantic and Pacific, 1,480 miles of Gold and Stock, 500 miles of Bell Telephone, 300 of American District, 702 Fire, 90 police, over 100 miles of law telegraph, and 30 miles of American Union, making about 4,662 in all. The Western Union and Atlantic and Pacific Companies have not increased their mileage over 20 per cent. in the past two or three years, while the local companies are increasing their mileage very rapidly. For instance, the American District Telegraph, which started in 1872, has now 300 miles. The Bell Telephone Company placed its first instrument in September, 1878, and at the end of the present year will probably have added 1,000 miles more to their existing 500. The Gold and Stock grows at the rate of 40 miles a month just now. Judging from these data, Mr. Radcliffe concludes that the trunk lines for New York ought to have a capacity of 1,000 wires each to meet the increased demand of the next ten years.

"HEDGING" ON EDISON'S ELECTRIC LIGHT.—The inventor of the electric light at Menlo Park, Mr. Thomas A. Edison, has not yet been able to get his light into practical operation, and the failure to do so is causing much criticism. At the beginning of the year he had about sixty lamps in successful operation, and his little carbon loop or horseshoe was glowing in them and furnishing a light that effectively replaced both gas and petroleum. He was run down with visitors and investigators, and in the rather loose way in which business was conducted in his workshops this seriously interfered with the manufacture of more lamps. He had the lamps put up in the shops, houses, and grounds, keeping accurate records of the performances of each. About ten days ago he found that quite a large proportion—some 15 or 20 per cent.—of the lamps were developing leaks, showing the vacuum to be defective, and he then experimented upon systems of obtaining a more perfect vacuum by trying different forms of lamps. Whenever the lamp maintained the vacuum, its performance continued perfect, and this was the case with many of the earlier lamps manufactured. But Mr. Edison is not content with this, and he desires to reduce the proportion of defective lamps to the smallest possible figure, and with this object his experiments are going on. The point where the platinum wires pass through the glass gives trouble on account of differences in expansion when the lamps are lighted. The tube at the upper side of the lamp through which the air is exhausted, and which is afterwards sealed up, also sometimes develops leaks, so that it seems to be demonstrated that effective sealing cannot always be secured when one side is a vacuum. The experiments are directed to remedying these defects in the construction of the lamp.

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When the vacuum is maintained, the lamp burns as successfully as ever, but as the time test has developed these difficulties, they must be surmounted before steps can be taken to put the invention in practical use. Hence nothing has yet been done to bring the lamp into operation outside Menlo Park ; and there are all sorts of criticisms and cavils at the delay. There are now about 80 lamps in operation at Menlo Park, some with changes of construction designed to obviate the defects that have been developed, and while Edison's friends claim that the difficulties are overcome, it does not yet seem to be practically demonstrated. Meanwhile the delays and adverse rumours are having their usual effect, and the Edison Light Company's stock, which had advanced to 3,500 dollars per share, has declined to 1,500 dollars for 100 dollar shares.—*Times.*

Competition in Telephony.—A correspondent of one of the Manchester papers calls attention to a feature in telephonic competition which will undoubtedly militate against public benefit if unlimited competition is allowed to have its way. The greatest advantage in this case, as in the case of letter carrying, will probably prove to be obtained by the adoption of a very enlightened monopoly. One firm, say, under the competitive system adopts one system, a second adopts a second system, a third a third, and so on. No. 1 wishes to converse with No. 2 or No. 3, but is unable to do so. Will the Gower give way to the Edison, or either to the Bell Telephone Company? Not so ; they will get who have the power, and they will keep who can. The extract below is a portion of the letter we have referred to :—"It has been asserted several times that the 'induction' difficulty has been overcome ; but if it is so, why don't we see the result of the discovery by all the wires being hung in some kind of order. As to the danger of falling wires, there is a light description of copper wire now being extensively used by Mr. Warburton, telegraphic engineer to the Lancashire and Yorkshire Railway Company, which is most suitable for street purposes, because if it falls it will not hurt anyone, besides, being so light it causes no strain on chimney stacks, and does not damage roofs when falling or being dragged along same, like the present heavy coarse iron wire. This is a very important matter to owners of property who allow wires to be attached to their places; but if the 'induction' difficulty has been overcome, the time has arrived for a wealthy corporation like Manchester to provide an iron pipe easily opened from the top, along the footways of all the chief streets, to contain all the telegraph and telephone wires. It might be made something like the water channels in Paris, and each company or owner of a 'set' of wires, if deemed necessary for extra protection, could cover them with metal, similar to a submarine cable, then all the unsightly overhead wires could be swept away. There is another matter of very great importance that should be taken up at once by the Chamber of Commerce, and that is the 'muddle' that will ensue owing to having two Telephonic 'Exchanges.' For instance, Mr. Smith, at his Ardwick Works, decides to have a connection with the 'Edison' Exchange, because on the other side of the town he has half-a-dozen firms he would frequently like to talk with ; but when his wire is finished he finds half his friends have used the 'Lancashire' Exchange, a different building, and using a different instrument, so that Mr. Smith only gets half the value out of his venture. The companies should either amalgamate or choose separate towns, though the latter mode would only prove a temporary relief, as the time is not far distant when the merchants of one town will chat with those of another, notwithstanding the Government telegraphic monopoly of the present day."

"The Biograph and Review" on Mr. J. Pender, M.P.—The January number of this monthly contains a very good biographical sketch of John Pender, M.P.; in fact, it gives us this best account of the lifelong energy which this gentleman has so eminently displayed. The reference to Mr. Pender's work in connection with Atlantic Telegraphy is particularly interesting. Thus, after the description of how Mr. Cyrus Field interviewed and obtained the assistance of Mr. Brassey, we read :—"Mr. Field, having thus found one powerful ally, says that he went out immediately in search of another, and next 'met a rich friend from Manchester (Mr. John Pender, M.P.), and I asked him if he would second Mr. Brassey, and walked with him from 28, Pall-mall, to the House of Commons, of which he is a member. Before we reached the House he expressed his willingness to do so to an equal amount.' From this point the path of one of the most enthusiastic missionaries of the Atlantic cable became more clear. In the course of a few days a combination was formed to carry on the business of making submarine telegraphs by a union of the Gutta Percha Company with the firm of Glass, Elliot, and Co., the principal manufacturers of sea cables, making one concern, to be called 'The Telegraph Construction and Maintenance Company,' into which Mr. Brassey entered, and of which Mr. Pender was to be chairman. Mr. Field speaks, in his "History of the Atlantic Telegraph," of 'a hitch in the arrangements,' which delayed active operations for a whole year. The hitch was in reality of more than a year's standing, backward and forward—it was the cable manufacturing question. Till this was determined there could be no real basis of capital investment. Glass, Elliot, and Co. could not be done without, and the resources of the Gutta Percha Company, holding many patents, were equally essential to the main work in view of the promoters. The combination of two independent firms of this position is one of the most difficult questions in practical commerce ; but to fuse two such firms into a general company on a novel, and, though great, not in the existing circumstances very hopeful enterprise, might fairly enough be considered a 'work of Hercules.' At this point of the Atlantic cable undertaking, Mr. Pender's remarkable talent of combining conflicting interests, and his own personal magnanimity, were alike strikingly displayed. The Gutta Percha Company, in going into the combination, was surrendering its all, and though not unwilling to enter into the proposition, and the terms in which it was much discussed, the company sought a guarantee for the value of its surrender. Mr. Pender, to solve a knot almost endless in its delays gave the Gutta Percha Company his own personal guarantee, which they accepted, for a quarter of a million sterling, and the work of the Atlantic cable from that moment went on apace. In 1865 the new cable, stowed on board the Great Eastern, under command of Captain, now Sir James, Anderson, and attended by a little squadron of lesser ships, was committed to the deep, and though the voyage was attended with extraordinary difficulties, and ended once more in failure mid-ocean, yet the disaster was unaccompanied with the dejection of previous failures: every fault of the cable had been repaired in the stormy progress of the vessels; no doubt was entertained even of the recovery of what had to be left during another winter at the bottom of the sea; and the following year saw another cable of 'The Maintenance and Construction Company,' under mutual arrangement with the Atlantic Company, laid safely from shore to shore, and the most novel and most difficult of all the great works of the century successfully accomplished."

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CONTRIBUTIONS TO A PHYSICAL THEORY OF ELECTRICITY.

BY DESMOND G. FITZGERALD.

(CONTINUED FROM P. 105.)

UNIFORM MOTION.

(Study.)

By Newton's first law of motion, uniform motion, when unresisted, continues indefinitely without expenditure of energy or performance of work.

But when motion is resisted, then, if it continue uniform, energy must be expended, and a corresponding quantity of work will be done. This applies to molecular motion as well as to the motion of masses.

Uniform motion must necessarily be preceded by accelerated motion. When the force producing the motion is constant, the acceleration cannot be uniform. The acceleration, or the rate of increase of velocity must diminish until, when its become *nil*, the motion becomes uniform.

Let us take the case of a mass which commences to move by the effect of an initial accelerating force $f-\phi$; this accelerating force becoming *nil* at the end of the time T, whilst the force f producing the motion remains constant. It is evident that the resistance ϕ must have increased, and have become equal to f. Considering the period T of variable acceleration which precedes uniform motion, it is evident also that the mean resistance overcome during this period will be a mean between ϕ and f which will be expressed by $\frac{f+\phi}{2}$, and that the mean accelerating force will be a mean between $f-\phi$ and 0, or $\frac{f-\phi}{2}$. Now since, in any case of accelerated motion, the time in which a given velocity v is obtained varies directly as the product of the given velocity into the mass moved, and inversely as the mean accelerating force in action during the required time, we have here:—

$$T=\frac{m\,v}{\frac{f-\phi}{2}}=\frac{2\,m\,v}{f-\phi};$$

and, in this case, generally,

$$f-\phi=\frac{2\,m\,v}{T}.$$

If this be correct, the product of the mean acceleration (mean accelerating force divided by mass) into the time T will, of course, be the final velocity. We have in effect

$$\frac{f-\phi}{2\,m}\times\frac{2\,m\,v}{f-\phi}=v.$$

The mean velocity during the time T will be $\frac{v}{2}$, and the space moved through will equal the mean velocity multiplied into the time, or

$$s=\frac{v}{2}\times\frac{2\,m\,v}{f-\phi}=\frac{m\,v^2}{f-\phi}.$$

Lastly, reverting to fundamental principles, it follows from the principle of the conservation of energy that (*the product of the mean resistance overcome, into the space through which it is overcome by the force applied to produce motion*) plus (*the kinetic energy accumulated in the moving mass*) equals (*the product of the force applied to produce motion into the space through which it acts.*) In the case of the period of variable (continuously diminishing) acceleration which precedes uniform motion, we have, therefore,

$$\frac{f+\phi}{2}s+\frac{m\,v^2}{2}=f\,s=f\,\frac{v}{2}\,T.$$

Here we have $f=\frac{f+\phi}{2}+\frac{m\,v^2}{2\,s}$, and $s=\frac{v}{2}\,T$.

When the motion becomes *uniform*, we have $s=v\,t$; whence

$$W=f\,s=f\,v\,t.$$

Thus, when uniform motion is produced against the resisting force of gravity,

$$W=m\,g\,v\,t.$$

Comparing the quantities of work done by a given force f, in the same time T, during the variable period which precedes uniform motion and when the motion has become uniform, we have in the first case,

$$s=\frac{v^2\,m}{f-\phi}=\frac{v}{2}\,T,$$

and, in the second case,

$$S=v\,T=2\,s;$$

which, neglecting potential energy stored up, gives a double value for work done.

In this latter case let the constant resisting force be R; we shall then have

$$R\,S=2\,f\,s=(f+\phi)\,s+m\,v^2.$$

and, since $S=2\,s$,

$$R\,s=\frac{f+\phi}{2}\,s+m\,\frac{v^2}{2}$$

and

$$R=\frac{f+\phi}{2}+m\,\frac{v^2}{2\,s}.$$

But it has above been shown that this is the value of f, therefore

$$R=f.$$

This demonstration, it may be observed, is scarcely required to show the necessary equivalence between the force producing uniform motion and the resistance opposing it; but it may be useful in order to show that the mean resistance opposing motion during the variable period which precedes uniform motion becomes augmented by $m\,\frac{v^2}{2\,s}$ before the motion becomes uniform.

$$\text{Since } 2\,s=\frac{2\,m\,v^2}{f-\phi},\quad m\,\frac{v^2}{2\,s}=\frac{f-\phi}{m\,v^2};$$

and we may write

$$f=R=\frac{f+\phi}{2}+\frac{f-\phi}{m\,v^2}.$$

And, again, since $2\,s=v\,T$,

$$m\,\frac{v^2}{2\,s}=\frac{m\,v}{T},$$

and

$$f=R=\frac{f+\phi}{2}+\frac{m\,v}{T}.$$

Let us now consider what will be the *power* in action *after* the period of diminishing acceleration which precedes uniform motion.

(*a*) This may be expressed as the quotient of the work R S by the time T in which this work is done. Thus the power will be

$$\frac{R\,S}{T}=\frac{2\,f\,s\,(f-\phi)}{2\,m\,v}.$$

$$\text{But } s=\frac{v}{2}\,T,\ \text{and}\ \frac{2\,s}{v}=T;$$

$$\text{therefore}\ \frac{R\,S}{T}=\frac{f\,T\,(f-\phi)}{2\,m}.$$

(*b*) Again, power is expressed by $\frac{W}{t}$; and, since in uniform motion $W=f\,v\,t$, $\frac{W}{t}=f\,v$. But the velocity must be the mean acceleration into the time during which it acts, or

$$v=\left(\frac{f-\phi}{2\,m}\right)T;$$

$$\text{therefore}\ \frac{W}{t}=\frac{R\,S}{T}=f\,v=\frac{f\,T\,(f-\phi)}{2\,m}.$$

The power in action *during* the period of acceleration is, f being constant, the same as that after this period if we take into account the potential work stored up in the mass, or, rather, the corresponding value of s. But according to the definition of power $\left(\frac{f\,s}{t}\right)$, taken in its literal sense, the power during the variable period will be *half* that in action during the uniform motion; since in the former case the space actually moved through is expressed by $\frac{v}{2}\,t$, and in the latter case by $v\,t$. Thus the value of $\frac{W}{t}$ after the period of varying velocity will be double the value of $\frac{f\,s}{t}$ during this period.

EXAMPLE. A fly-wheel, the periphery of which weighs 4 cwt., is connected by cogs with a crank, to the handle of which a force may be applied to produce motion. The crank handle revolves in a circle the diameter of which is half the mean diameter of the wheel. It is found that a mass of 14 lb., suspended to the crank handle when the crank lever is in a horizontal position, is barely sufficient to produce motion in the fly-wheel. A force equivalent to the weight of 28 lb. is applied to the crank handle in such manner as to act continuously at right angles to the crank lever, and it is found that when the periphery of the fly-wheel obtains a velocity of 100 ft. per second the motion becomes uniform. In what time does the motion thus become uniform, and what will be the power in action at the end of this time? It is supposed that the mass of the moving parts of the machine

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minus that of the fly-wheel is negligible as compared with the mass of the fly-wheel.

Here $m = 448$ lb.

$$f = 28 \times g = 28 \times 32{\cdot}2 = 901{\cdot}6 \text{ abs. units.}$$

The force virtually acting upon the mass of the fly-wheel will be half this; but the space moved through by this mass will be double the space moved through in the same time by the crank handle. If we take f as above we must take $v = 50$ ft. per sec.

$$\phi = 14 \times 32{\cdot}2 = 450{\cdot}8 \text{ abs. units.}$$

$$\text{Now } f - \phi = \frac{2mv}{T},$$

$$\text{and } T = \frac{2mv}{f-\phi} = \frac{44800}{450{\cdot}8} = 99{\cdot}38 \text{ seconds....(Ans. 1.)}$$

The *power* in action at the end of this time will be

$$\frac{W}{t} = \frac{fT(f-\phi)}{2m} = \frac{901{\cdot}6 \times 99{\cdot}38 \times 450{\cdot}8}{896} = 45080 \text{ abs. units.}$$

(Ans. 2.)

If this be correct, these figures will express the value of fv. In effect we have

$$fv = 901{\cdot}6 \times 50 = 45080.$$

(TO BE CONTINUED.)

THE TELEGRAPHS OF THE GERMAN EMPIRE FROM 1876 to 1879.*

(CONTINUED FROM PAGE 106).

PNEUMATIC COMMUNICATIONS.

The working of the pneumatic tubes known by the name of the tubular post, and used conjointly by the postal and telegraphic services, was commenced on December 1, 1876.

The usefulness of the telegraph, says the Report, is relatively less for small than for long distances, since the absolute velocity of telegraphic transmission is almost independent of distance. For short distances, therefore, transmission by compressed air offers appreciable advantages over electrical transmission; allowing as it does of the simultaneous despatch of several telegrams, whereas with electrical apparatus signals and words are forwarded successively.

The number of offices for the tubular post, which at the commencement was 15, amounts now to 23. These offices meet the requirements of the most important districts of Berlin, and are connected with the central telegraph station, as well as with each other. The total length of the tubes is 38·71 kilometres. The compressed and rarefied air requisite to work the tubular post is supplied by six sets of machines, each comprising two steam engines in connection with pneumatic pumps. The transmission is effected with a mean velocity of 1,000 metres per minute.

The establishment of the tubular post necessitated an expenditure of 2,736,700 marks, inclusive of the cost of purchasing land; this sum being supplied by extraordinary credits.

The construction of the steam engines and pneumatic pumps, as well as that of the apparatus for transmission and reception, has hitherto been found quite satisfactory.

There has been transmitted through the tubular post

In December, 1876	94,495	missives.
In 1877	1,360,874	,,
In 1878	1,464,870	,,

showing, for 1878, 285 missives per day more than in 1877.

II. OFFICES.

As might have been anticipated, the development in the means of communication has been attended with a corresponding increase in the number of offices. The results brought forward in the report of the German administration seem to us, however, considerably in excess of what might have been expected from the extension of telegraphic lines and wires. These results are due in great part to the facilities for opening new offices consequent upon the amalgamation of the two services; but they are also dependent upon another cause, viz., that Germany is the only country which has applied telephony in public telegraphy. In other countries where the telephone is used—in the United States, England and France—the object has always been to enable correspondents to speak directly to each other; nowhere, except in Germany, has it been considered as a new and more economical apparatus for public telegraphy, allowing of the transmission by *employés* of the administration of the messages entrusted to them.

* Translated from the *Journal Télégraphique*.

GENERAL AUGMENTATION IN THE NUMBER OF OFFICES.

At the end of January 1875, when the amalgamation of posts and telegraphs—at first provisional, but definitively adopted on January 1st, 1876—first took place, the number of telegraphic offices was 1,686. At the end of December 1878, this number had increased to 4,143; showing an increase of 2,457 offices, or 245 per cent. In all parts of the empire, numbers of localities and districts until then outside of all telegraphic communication were included within the network. This great augmentation of the number of offices has also created great facilities for telegraphic traffic in the case of villages and country districts which are now at a less distance from telegraph stations. The execution of the plan for extending the network had been spread over a period of 4 years (from 1876 to 1879). It will therefore be completed at the end of the present (1879) year. The administration of the Empire will then possess 5,000 offices, a number which has been reached by no other country in Europe. (At the end of 1877, the period of the last statistics, England has 3,756 stations, France 2,984, Austria-Hungary 1,431, Italy 1,292, Russia 932.

The old municipal telegraph offices have been abolished and transformed into offices belonging to the State, and whilst being amalgamated with the Post Office they have been incorporated with the present system of the administration.

In profiting by the post-offices already in existence the establishment of new telegraphic offices has been effected with greater facility and promptitude, and at a less cost than would have otherwise been possible.

TELEPHONIC OFFICES.

The application of the telephone to the exchange of communications has also contributed to diminish the cost of establishing the offices, and, consequently, to increase the facilities for extending the benefits of the telegraph to unimportant localities.

The first trials made at Berlin with the Bell telephone, on Nov. 5, 1877, on a telegraphic line between the central building of the Post Office, Leipziger-Strasse, and the central building of the telegraphs, Französischen-Strasse, had at once shown the importance of this mode of transmission. The Administration, therefore, immediately proceeded to carry out fresh experiments on a larger scale. These experiments having also been attended with good results, and having removed all doubts as to the possibility of transmitting telegraphic communications by telephone up to a distance of seventy-five kilometres, the Administration issued orders to put up telephones at certain telegraphic stations. It was especially with the view of bringing into connection with the telegraphic system localities where, for different reasons, the use of the Morse was not possible, or appeared too costly in regard to the anticipated traffic, that the telephone was employed. The cost of establishing a telephonic station is much less than that of a telegraphic station furnished with Morse apparatus, and the service of the telephone does not necessitate *employés* who have received a long and expensive preliminary training.

At the end of March, 1879, the number of working telephonic stations on the territory of the Empire amounted to 389. The results obtained having been satisfactory, the Administration proposes to augment this number.

In the course of establishing these stations, an improvement made by M. Siemens in the Bell telephone was successful in considerably strengthening the sound of this instrument, and, consequently, in obtaining greater distinctness in the telephonic communications. Since this improvement could be applied without using special call-arrangements, the fitting-up of the telephonic stations was considerably simplified.

The introduction of telephonic offices upon lines already in existence has in many cases allowed of a more extended utilisation of these lines, in the sense that two stations included in a circuit can exchange communications by telephone whilst two other stations in the same circuit correspond by means of the Morse apparatus.

The telephone has also been successfully employed within the circumscription of the head Direction of posts at Berlin. At the present moment telephones connect

1. The post offices of Friedrichsfelde and Rummelsburg;
2. The postal agency of Britz and the Rixdorf post office;
3. The Martinikenfelde and Moabit post offices;
4. The postal agency of Wilmersdorf and the Shœneberg post office;
5. The postal agency of Reinickendorf and the Gesundbrunnen post office;
6. The postal agency of Lichtenberg to the Friedrichsberg post office.

(TO BE CONTINUED.)

PRIX DE VOLTA.—This prize of 50,000f. has been awarded to Mr. Graham Bell by the Committee appointed by the French Minister of Public Instruction.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

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SCIENCE AND CAPITAL.

Capital when properly administered is the very lifeblood of scientific applications and investigations; and enables them to develop with freedom and rapidity. Without capital science is frequently helpless; for the secrets of nature cannot be laid bare without patient and oftentimes expensive research. The vast amount of mere time required to pursue an investigation to successful issues, or to invent a new machine which will practically answer the purpose for which it was designed, is sufficient of itself to put serious experiment beyond the power of otherwise busy men, without taking into account at all the money necessary to provide experimental apparatus and materials. Thus it follows that only those who have the time and money, or, to put it briefly, the capital, to spare can engage in physical research, whatever be their bias or abilities for the work.

But, if capital ought and does exercise a fostering influence on science, the debt is not all upon one side; for science in return enormously increases the means of accumulating capital. Fabulous sums have been made out of single inventions and discoveries, and the chance observation, or the happy thought of a philosopher, has enriched multitudes. It is good policy even as a money speculation for the man of capital to endow the man of science; but there is great danger of his patronage being carried too far; and the times are giving us proof that it were better perhaps if science had not to depend so much upon his support. When the servant becomes the master, when the baser rules the nobler, when capital is dominant over science, and science, forgetting its high prerogative and holy purpose, becomes the menial and the sycophant of lucre, it is high time that this degrading connection should be severed.

To fully realise the extent to which this pernicious abuse has gone in these days we have only to turn our eyes to America, where the rage for capital is proverbial, and the highest impulses are prostituted for the sake of the "almighty dollar." In America nothing seems to be held sacred from the blight of trade. The seats in churches are let out to the highest bidder, the picturesque rocks which beautify the romantic scenery of the Hudson river are placarded with puffs of patent medicines and Yankee notions, "Brandreth's pills," and "apple parers". A young painter, if he would flee the sordid spirit and prevent his own artistic ruin, must escape to Europe and study there; and, because of its rich potentialities in money, the search for physical truth has there become a kind of gambling. Inventive genius is at a premium, and discoveries are bid for. Stock companies are formed to work the brains of a man, and reputations are employed as the unprincipled levers of reckless speculation. Professors in universities defile the dignity of their mission by pandering to the national vanity and besetting sin, and use the status of the professional chair to float some bubble company or tout the latest mechanical "humbug." The teacher is still considered a venerable person in these old-fashioned islands, and the public lecturer is a man to be admired; but in the Land of Light he is simply the agent of a firm, and all his gospel may be summed up in the command to buy his patron's "coffee grinder." As for the Press, the less said about that the better perhaps. It has become the receptacle for all the news which the world can supply or man invent; every rumour, every remark, every notion or incident, whether it be true or false, sense or nonsense, foul or clean, is reckoned worthy of a place in the enlightened organs of the great Republic. Science was once protected from the fatal notice of reporters by their own ignorance and apathy, but since the discovery of the recent popular marvels, the telephone, microphone, and phonograph, they have invaded the halls of research in a prying swarm, and there is absolutely no asylum from their impertinent raids. The only thing that a man of science in America can do to escape their harassing intrusions is to lay a mine at the threshold of his laboratory, and threaten to blow up the first that enters. The blundering havoc which the American press has made with scientific progress, the false ideas and glaring errors about new inventions, the rash and wretched "bunkum," and the libellous aspersions on the individual character which have been disseminated by the American newspapers since they began to honour science with their attention, are a striking commentary on our text. We have only to turn to their closely printed, omniferous pages for the last few years to find there the disgraceful annals of many an exploded "motor," spurious discovery, illicit claim to invention, and worse than all, the record of depraved genius and splendid fame which has been bought and sold.

We have spoken strongly on this matter; for we think that a protest, strong and to the point, is emphatically called for, if for no other reason than that of the contagiousness of an example which hitherto the Press in this country cannot be said to have followed, but which it may be said to have insufficiently rejected and condemned.

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CORRESPONDENCE.

THE POSITION OF TELEGRAPHISTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the last issue of the *Journal Télégraphique* there is one of the most useful and telling articles that has possibly ever appeared in it, entitled "Observations on the Position of Telegraphists," by M. Charlier, of Liège, and as frequently that paper is thrown aside as having too much official and statistical matter about it, there is every possibility that it will meet with but a very limited notice. I have, therefore, translated it, and beg you will kindly accord me the necessary space for its appearance.

It is an article which merits the most earnest attention of every person interested in telegraphy, and deserves a world-wide circulation.

Appearing almost contemporaneously with your excellent leader of December 27th, which so accurately describes the *past* and *present* state of the telegraphist, we get from it an insight into the *future*.

The telegraphic world is annually spending thousands of pounds in producing apparatus, which, although they denote the progress of mechanical art and brilliant embellishments, are *de facto* only beautifully elegant plagiarisms of our elementary systems, and we are only now seriously awakening ourselves to the fact that it is not to the apparatus that we must look, but to the operator. How natural and true is the paragraph "that the most elementary apparatus in the hands of an able clerk can cope with the latest improved ones"!

Every practical telegraphist knows that there are occasions when, even with the most perfect lines and apparatus, signals are liable, through the thousand and one causes inherent to the science, to miss, split, or stick, and unless the intelligence of the clerk can fill up the hiatus, valuable time is wasted in repetitions or faulty corrections are made.

There is nothing extraordinary in the feats of clerks who can get through a mass of work rapidly when the signals are *constantly perfect*. Place him on a circuit where messages are in a language unknown to him, with indifferent signals, and he at once falls to the level of the young beginner; but place a linguist in his position, and, provided the messages are in *clear* language, you will see him unhesitatingly receive every one without repetition or error. This is not a theory, but a practical fact of hourly occurrence on lines where the traffic is in four or five different languages, and, if space permitted me, I could give you numerous examples where the intelligent linguist daily modifies mechanical defects, and cite cases where most serious errors of immense importance would have happened but for the ability of the *employé*. Let us, therefore, hope that every administration will favour this idea, and, in appointing and promoting their clerks, make it a *sine quâ non* that their abilities include also the knowledge (not superficial, but profound) of one or more modern languages besides their own. X.

Zante, Jan. 16th, 1880.

"We recently quoted from an eminent authority the change which is rapidly taking place in telegraphy, tending to bring all the different systems of transmission to the most simple formulæ.

"From this technological phenomenon we may observe the verification of a well-known law, according to which mechanical results never reach the perfected development of simplicity until they have passed through the most complicated transformations. We, however, think it would be more exact to attribute it to another cause. According to our idea, the principal reason consists in this fact (inherent to the nature of telegraphic operations), that the intelligence and aptitude of the operators enter more into the work and occupy a larger share than the mechanical arrangements, however precise. It is a fact that we daily see the most elementary apparatus, when placed in competent hands, compare favourably, and often equal in rapidity, the most elaborate perfections, considered the quickest *par excellence*. The intelligence and ability of the operator can always make up for the shortcomings of the instrument, but we defy any mechanical arrangement, however perfect, to enable us to do without the services of the intelligent clerk. For this reason we may consider the idea (unfortunately, too generally believed) that we shall eventually be able to replace the *employé* by mechanical automatons, as purely Utopian. We can hardly share the opinion of a certain correspondent of the *Journal of the Telegraph*, that the telegraphist is but the complement of an imperfect instrument, but we consider that the soul of every system of telegraphy is the agent who guides it and puts it into operation; and it is well known that it is precisely for the most complicated instruments that an intelligent and able staff is required.

"Let every operator, therefore, reassure himself that, in spite of all that is said to the contrary, their help is far from being menaced; and all future discoveries in this science, instead of being unfavourable to them, cannot but contribute to increase the importance of their services.

"A simple consideration appears to us to fully justify this confidence in the future.

"As we have already stated, telegraphy will undoubtedly conform itself entirely to the most simple and inexpensive apparatus at a very early date. The first result of this *revolution* will give more work to the staff and increase their activity; but we shall have a very sensible improvement in the economy of the service, by cutting off that continuous expense for new apparatus, an improvement the benefit of which operators cannot fail to benefit by. Looking from both the financial interests of the administrations and the position of the *employé* sides of the question, the matter we have taken in hand is one of the first importance.

"If it is shown that the amount expended for salaries, &c., absorbs, as a rule, the best portion of the income, it must be allowed—and daily this fact is becoming more evident—that the entire success of the work depends upon the intelligence and activity of the *employés*.

"Too long certain strange prejudices have reigned supreme as to the actual value to be accorded to telegraphic operations. It is generally supposed that the art needs but a mechanic of both limited education and intelligence. We have often heard it said that a simple mechanical apprenticeship is enough for enabling a clerk to work the instrument; after then it is but a question of practice. Elsewhere we have heard of staffs composed entirely of youngsters who had hardly received even an elementary education, and yet this was supposed sufficient for the necessities of the service. Grave errors these, which, however, have been generally rectified where experience has proved the fallacy of such a system, because we cannot ignore the fact that the exigencies of the service are extremely complex, and in general require more knowledge and ability than any other administrative position. Not only must a telegraphist have attained the same degree of ordinary instruction required for any other office, but also a sufficiently extended knowledge of chemistry, physics, mathematics, &c., to say nothing of the aptitude he must acquire, frequently at the expense of immense sacrifice, for enabling him to participate in active manipulation. For becoming a complete telegraphist, perfectly at home in his functions, he must also know (and on this important point we expressly insist) some foreign languages, or at least it is essential that he should have a good notion of several different ones.

"One must be indeed a stranger to telegraphy to see in this the least affectation. On the contrary, more than ever the conviction is firmly establishing itself, sanctioned by experience, that the intrinsic merit of the *employé* is the first necessity for ensuring a good service.

"The work of telegraphy, as a very clever officer has already expressed in this paper, demands all the faculties of a clever, educated man, perfectly conscious of the value of his activity, and animated with a love of his profession. Ought we not to say of the telegraphist that which Napoleon said of man in general, "*Qu'il doit être carré*"? To realise our *beau ideal* of a telegraphist, we consider he ought in reality to reunite, up to a certain point, every quality a man can possibly be endowed with. To the intellectual aptitude, acquired by education, must be added physical faculties, complete and well developed, notably that delicacy of sense which characterises the crack operator.

"If we were not afraid of going too far in search of our examples, and to inspire us with the ideas of a people whose temperament is so different to ours, we would cite the United States of America, where telegraphy has made the most rapid progress, and where the position of the telegraphist is one of extreme consideration. There a mass of distinguished men consider it one of the chief of honours to have practised telegraphy, looked upon as the chief of all the scientific professions in that country.

"Nothing, therefore, justifies the narrow limits in which it is endeavoured to retain the character assigned to the telegraphist, but in order to have a staff really with these capabilities, and to maintain it in excellency, what is needed? Evidently we must favour his intellectual developments in granting him a position and fixing his remuneration according to his talents and the services that may be demanded of him.

"Although many very commendable exertions have been made in most of those administrations where the telegraphs are in the hands of the Government for organising their respective staffs on a favourable footing, and for ensuring them those advantages which they are justified in pretending to, it is still evident that almost everywhere the telegraphic operators are far from attaining the equivalent positions of their more fortunate colleagues in

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other Government departments. Why does this difference of treatment exist? and why is a line drawn between functionaries equally useful to the public service? Is it because there exists the fallacious pretext that the telegraph brings in little or no income? We have often heard this reason adduced.

"Now what importance can be attached to this consideration when it is admitted that the institution is indispensable? It is both desirable and just that the public service should be the least onerous possible; but in no country that we are aware of have the legislative powers who decreed the establishment of telegraphs insisted upon this *desideratum*. Other more useful services were required from the new institution than an increase to the revenue, and the financial part of the question was left entirely for after consideration.

"In losing sight of the fundamental principles on which the organisation of telegraphy is based we should be viewing the situation as irregular, when it is perfectly correct.

"The question of foreign languages, which we have just alluded to, is considered most rightly of the highest importance. Those who doubt it can know but very little of the practical part of the profession. Telegraphy is by its nature to a great extent cosmopolitan, and, therefore, has exigencies entirely exceptional to other professions. It is not like the postal department, where the contents of messages are unknown to the *employé*. Here everything must be read, deciphered, and understood; therefore, the operator, whose knowledge of foreign language is very limited or absolutely *nil*, remains always an *employé* incomplete, ordinarily insufficient, and in general of but little use in various operations. In the receiving offices, notably at the chief stations, this condition becomes a necessity of the first order for clerks in their relations with the general public. In the instrument rooms, foreign messages must be read off in transmission, and explanations exchanged with foreign stations, and finally the regularity and celerity of all telegraphic operations are subservient to the above-mentioned exigencies. Everybody is aware what advantages the linguistical clerk possesses in every respect over his colleagues; he acts quicker, his work is done with less hesitation and always more correctly, and, in a word, his capacity as an operator is of a higher order. In his direct relations with foreign stations his services become at any given moment extremely precious, almost indispensable.

The study of foreign languages is most justly considered, nowadays, as the complement not only of a superior education but even of a moderate one; and, from the point of view we are now looking, it is easily seen that there is no other position whatever where this particularity finds a practical application more useful or more extensive than in telegraphy.

"For several years past instruction in the public schools of Belgium has made a sensible progress in this respect. Numerous classes for foreign languages have been opened in the chief schools and universities, and it is now a question of opening similar ones in the elementary schools. Special scholarships have also been created in the superior schools for training the teachers required for this purpose. Such useful reforms are worthy of the greatest praise, and the telegraphic adminstrations will be the first to reap the fruits thereof, because in future the ranks of their staff can be filled up with men of superior education.

"At certain periods in the progress of telegraphy, notably when the tariffs were reduced, clerks were taken on without regard to examination; but to-day nominations are only granted after having passed a rigid examination in which languages have a most prominent feature. The State which thus takes such a lively interest in the people's education is directly the cause of this reform, and it is necessary that its choice fall upon young men who may not only serve their country well in ordinary positions, but become capable of turning out eventually superior officials.

"The moment has arrived for giving every encouragement to knowledge in general and to linguistical acquirements in particular, and in admitting these as an exceptional title for acceptation in the telegraph service, and offering a remuneration proportionate to their services, the taste for study will be enormously developed, not only in the aspiring telegraphist, but in all the most interesting classes of our population."

LODGE'S ELECTROMETER KEY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of November 1, 1879, p. 285, under the heading "Stray Notes on the British Association Meeting," one of your contributors has been good enough to make some valuable remarks upon the high insulation key which I exhibited there, and which a committee of the Association, consisting of Profs. Ayrton and Perry and myself, has been appointed to improve and construct. (See *The Electrician*, 20th Sept., No. 18, p. 211.) I intended to have replied to these observations at the time, but other things put it out of my head.

The conductors in my key are supported solely by silk threads, and although this gives very perfect insulation, more perfect I believe than can be obtained by any other means, yet, as your correspondent observes, it has its defects, as the manipulation required is rather delicate and the instrument altogether is rather fragile for practical working. Moreover, it is perfectly true that so long as there are holes in the case for the wires to pass through without touching anything it is impossible to artificially dry the interior.

Nevertheless, I hope that we may be able to contrive an improved arrangement in which the conductors shall be suspended, without any lateral play, by means of fine unfingered and carefully selected silk threads, without having to make use of ebonite, as your contributor suggests, which I feel sure would be a step in a backward direction.

I have had a lot of trouble with ebonite keys, and have come to distrust them for very delicate work. When clean and new, and dry, no doubt ebonite insulates exceedingly well; but if you touch it, it becomes electrical, and it is then very difficult to discharge again. Worse than this, however, is the coating of moisture which forms on its surface, either from the effect of light or London air, I don't know which, but it is sure to form before very long, and the key wants a thorough washing before it can be used. This coat of moisture not only makes it leak, which is objectionable, but it makes it act as a battery, which is villainous.

Take any ordinary key and connect its insulated brass pieces up to a condenser: in a few minutes you will find the condenser has acquired a slight charge. I noticed this first with a commutator at University College which has an ivory cylinder with two brass pins imbedded in it. This ivory acts as the exciting fluid of a battery, and though the two metals in it are both brass it possesses an electromotive force obtrusively evident with a condenser and delicate galvanometer. The film of moisture on an ebonite key acts in the same sort of way, though not so powerfully.

For myself I think that in any space which is artificially dried it is difficult to beat the insulating power of good glass.

But I hope that, with carefully selected and properly arranged silk threads, it may be possible to suspend the conducting wires inside the case of the electrometer so as to get almost perfect insulation without artificially drying the interior.

Prof. Ayrton was good enough to measure the insulation-resistance of the conductors in the key exhibited to the B.A., which were suspended by an inch or two of rather coarse silk which had been a good deal handled. One of them was 7, and another 28, thousand megohms.

This is a long way off perfection; but, nevertheless, it indicates that, with good unfingered silk, a very high degree of insulation may be ultimately attained.—Yours, &c.,

OLIVER J. LODGE.

A MAGNETIC TRANSMITTER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It has occurred to me that a vast amount of battery power is employed to produce comparatively trivial results. Why not do away with batteries altogether for telegraphic purposes, and rely on magnetic electricity for the transmission of signals? The labour expended in depressing a Morse key is surely capable of producing a magnetic current sufficiently strong to give a signal at a considerable distance. The suggestion may seem very unorthodox; but allow me, Sir, to explain more definitely what I mean. A magnetic current is generated in a coil of wire by bringing a permanent magnet near the coil. If, therefore, a number of magnets were to be brought simultaneously near a number of coils in one circuit, a strong current would be produced; and if a delicately balanced lever were constructed with a key at one end and a number of bar-shaped magnets at the other, the power required to move such a lever would be small. If then, say, fifty magnets were to be simultaneously withdrawn from the centres of fifty coils, each of considerable length, I venture to think that a sufficiently strong current would be generated in the coils to send a telgraphic signal from Land's End to John o'Groat's Land, or even further. Perhaps it would be advisable to complete the electric circuit only at the moment when the key was down in order to get the full effect of the magnetic current, and to prevent a second current being sent in the opposite direction when the key sprang back.—Yours, &c.,

CHARLES STEWART, M.A.

50, Colebrooke-row, N., 31st January, 1880.

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THE ESSENTIAL NATURE OF ELECTRICITY.

BY J. T. SPRAGUE.

Mr. FitzGerald will undoubtedly tend to produce a more definite and general conception of electricity and of electrical force by means of his interesting series of "Contributions to a Physical Theory of Electricity," even if he does not succeed in convincing any one of the existence of electricity as an actual entity, fluid, or form of matter, ponderable or otherwise. It was my intention to await the conclusion of those papers before making any remarks thereon, or in reply to the column of criticism on my own views, which my friend devoted to them p. 20, Nov. 29th. But, after all, I do not mean to discuss Mr. FitzGerald's propositions at present, but simply to show that there is not, in my own theory, either the hiatus or deficiency asserted, or the failure to occupy the ground which Mr. FitzGerald seeks to occupy by his theory. Therefore, there seems no good reason against at once explaining these points, and showing that my own theory, when fully understood, is in perfect accord with all the rest of that physical theory of electricity which Mr. FitzGerald is working to develop, and does actually fulfil the exact functions which he considers necessitate the existence of an actual electricity, a fluid or form of matter. I am moved to writing at this time by a statement on p. 83 "*(c)*. If the quantity be a form of matter, it is acted upon by force, and constitutes a *vehicle for energy* with which and from which it may be alternately associated and disassociated. But its conversion into energy or any mode of motion will be a matter of absolute impossibility, and consequently it can have no mechanical equivalent, or will not be susceptible of being expressed in terms of any unit of work." Most true. Turning back now to p. 33 we find these words, "We can arrive at the logical form of the proposition, which in reality underlies the views which have sometimes been erroneously dignified by the title of 'The Dynamic Theory of Electricity,' viz., the form which directly denies the objective existence of any thing corresponding to that which is apparently measured by the voltameter or galvanometer, and which is expressed by the formula $\frac{E}{R}\theta$ or $\frac{T}{R^i}$." On p. 34 we find the distinction between the values expressed in formulæ as $\frac{E}{R}$ and $\frac{E^2}{R}$, and the statements made that the first of these is "material or analogous to matter, and may be represented to the mind by the expression imponderable fluid." Again, "There is an electrical energy necessarily equivalent to $\frac{E^2}{R}$, which is the true cause of electrical phenomena, and which may be converted into heat and work."

I see and maintain this most important distinction as fully as Mr. FitzGerald; it is not dealt with in the general vague ideas of electricity as a "mode of motion," and in the quotation from Prof. Barrett, p. 34, the two are so mixed up as to result in absolute error, for "the missing quantity having been converted into heat" is a pure mistake. Electricity—that which is measured by $\frac{E}{R}$ (that is to say C or current) is never converted into heat or work, or into anything whatever.

But in what I have called in my work the dynamical theory of electricity, though I deny the *objective* existence of any *thing* corresponding to this value C, that is to say a fluid, yet I have provided an agency which does accomplish all that is involved in $\frac{E}{R}$ as distinct from $\frac{E^2}{R}$ and does all that the supposed "fluid" is invented to do without our having to create this additional and unknown form of "matter." This, then, I now propose to fully explain, in order that this idea may be used concurrently with all the other principles in the physical theory of electricity by simply substituting it for the idea of the material fluid. To fairly compare the various theories of the actual nature of electricity, it is necessary to bear in mind the process by which those theories grew into existence. The first knowledge obtained of electricity was of its static actions, the apparent phenomena of generation or separation from matter, charge and transfer from one vessel to another; these phenomena do bear so strong a resemblance to similar operations with gases that it was almost inevitable that their cause should be attributed to a substance similar in character to gases, though incapable of actual appreciation except by its actions. When current electricity was discovered and grew into importance, much labour was expended in fitting the old theories to the new facts. But these were much less adapted to them, and there can be little doubt that had current electricity, with its chemical and magnetic relations, been the first to be thoroughly examined, and especially if this examination had been deferred until some clear ideas had been obtained of the nature of force and energy, the fluid theories of electricity would never have come into existence or found much acceptance. For this reason it appears to me that we need to reverse the old process and to give our attention mainly to the phenomena of *current* electricity. In fact, it is here only that we can trace the connection between electricity and matter, for here we find that there is an absolute relation between what we call electricity and the molecular and equivalent constitution of all material substances, a relation which is by no means apparent, indeed, requires to be traced out in the phenomena which we call the actions of static electricity.

Let us then examine the fundamental facts of the current. We find, first, two phenomena perfectly analogous to those of any material current, which may be very fairly compared to the passage of water through pipes. These are (1.) an apparent transfer of a "quantity" (be it what it may) which we express in formulæ as C or "current," and which is defined in the accepted formulæ of Ohm as $\frac{E}{R} = C$. This is, in fact, perfectly analogous to the pint or pound, gallon, or cubic foot per minute of hydraulic formulæ. We have also (2) a transfer and expenditure of energy related to E^2 or C^2, which is also perfectly analogous to the energy transferred and expended by a current of water. If we take closed circuits or currents including the generator of currents in both cases, electric or hydraulic, the analogy is perfect, as I have shown by diagram and reasoning, p. 204, of my "Electricity; its Theory, Sources, and Applications," But besides these two facts we have also (3) an external action called Tension, and measured as difference of Potential, also analogous, as I have shown, to the pressures in the pipes of a closed hydraulic system. Here, however, this mechanical analogy ceases, and we come upon phenomena peculiar to electricity, for we find that this dynamic current has actions outside of itself. (4). Static induction effected in one direction as the current commences to move, and in the other when it stops, but incapable of doing any work while the current is actually passing. (5). Magnetic induction, by which the magnetic state and force is set up in matter, by which work is done by the current while passing, and by which the energy of the current is actually absorbed and expended in external work; and (6) chemical action set up within the circuit of the current itself, and bearing very remarkable relations to the "quantity" of the current, explainable only on the ground that this "quantity," be it what it may, is absolutely dependent upon the molecular constitution of the matter transmitting the current, and not, as in the case of water, upon the mass or measure of any "matter," the motion of which constitutes the actual current itself. It is the last set of facts which are inconsistent with the conception of electricity as a matter or fluid.

In Fig. 1 I endeavour to show the merely mechanical or material idea of a current. It may be considered as a length of a pipe or conductor; each square represents a unit of "quantity," a pound or gallon of water, or an electric unit, so that "current" will be measured by the number of units passing across the middle line per second. This is the quantity, $\frac{E}{R} = C$, and this quantity or current (in a closed circuit) will be equal in every section of the circuit, whether this be a single conduit, or divided into many. By the well-known laws alike of hydraulics and electricity, the energy needed to set up this current, and the energy transmitted and expended by the current will be as the square of the current C^2, or (as C is always proportional to E, or force, as defined in the various cases) it is represented by E^2. Thus, we have in plain view those two quantities insisted upon by Mr. FitzGerald—the one a moving fluid or matter, according to him, an agency, as I seek to show, unchangeable and inconvertible into anything else; the other, energy capable of transfer and transformation.

Looking at Fig. 1, we understand at once that each single quantity, the unit velocity of which constitutes the unit of energy, will give these two results, a quantity or current varying as its direct ratio of motion, and energy or work varying as the square of its ratio of motion.

FIG. 1.

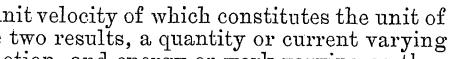

Fig. 2 represents another idea of a conductor of energy, consisting of a series of wheels connected together, so as to move equally on their axes without change of place. If we now conceive that each single rotation of a wheel is our measure of "quantity," instead of the actual motion of transmission, as in

FIG. 2.

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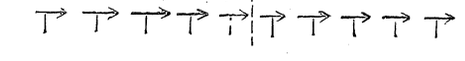
Fig. 1, we have precisely the same results. We still measure by a number or quantity arrived at by precisely the same formulæ; this "quantity" will vary as the direct number of rotations and the energy absorbed and transmitted will vary as the square of the rotations. We have substituted a simple "mode of motion" *inconvertible into work, not expressible in terms of any mechanical unit,* for the matter or fluid possessed of these functions, and yet we have the same quantitative results, and the same "energy" capable of transformation.

In Fig. 3 we have the same principles in another form; a series

FIG. 3.



of magnetic needles on centres, which will rotate and transmit energy in a manner similar to the wheels in Fig. 2. Practically, of course, that is, as a machine, this plan would not work as perfectly as the wheels, but it serves as a means to carry our ideas from the rough mechanical stage into the field of molecular physics. We see by it that energy is transmissible by means of a "mode of motion," which is not itself energy, and which produces the effects of current without the transfer of matter, while still we have the same two important factors as before.

THE ELECTRO-TECHNICAL SOCIETY OF BERLIN.

DR. WERNER SIEMENS ON ELECTRIC RAILWAYS, &c.

The first meeting of this newly-founded society took place in the buildings of the telegraphic department of the General Post Office, Berlin, Dr. Stephan, Postmaster-General of the German Empire occupying the chair. In his inaugural address the chairman said:—Gentlemen: In opening the first sitting of the Electro-Technical Society I feel greatly honoured in greeting you and bidding you heartily welcome in these rooms. You will no doubt share with me the pleasure I feel at the fact that to-day, hardly a month after the society started into life, so numerous and distinguished an assembly should be found here met together. The number of members of the society, as you will have learned from the first number of the society's journal which you have received, is already 545. Since then an additional number of adhesions has been sent in by gentlemen from all parts of Germany, and a few from foreign countries, bringing up the total of our members to 736. They represent the learned world, professional technicians, the army, the navy, the civil service, trade and commerce, education and art, wholesale manufacturing industry and agriculture, in fact, every circle of educated society. This is certainly a very gratifying sign that the fundamental thought which animated us in establishing the society, I mean the connection between science and practical life in the field we purpose cultivating, has met with great sympathy in the widest circles.

After some further observations Dr. Stephan said, "I ventured, as representative of Prince Bismarck, the Imperial Chancellor, to submit to his Majesty, the Emperor, an account of the aims of our society, and in reply I received, on the 21st ult., the following autograph letter:—"

"From the account sent by the Imperial Chancellor on the 8th inst., I have been particularly gratified to gather that, at your instigation, an Electro-Technical Society has just been founded in Berlin. The objects more particularly defined in the statutes of the society have my full approval, and the means adopted to attain them appear to me to be well adapted to the purpose. I hope that the high expectations which the aims of the society are calculated to awaken may be abundantly fulfilled, and I shall take a lively interest in hearing of the success of the society. Signed, Wilhelm, Berlin, January 21, 1880." Dr. Stephan further read a letter of almost identical import, which he had received from the Crown Prince of Germany.

The secretary of the committee of management then gave his first report, from which it appeared that, out of the 545 members who had joined, 191 were resident in Berlin, 242 in the provinces of Prussia, 99 in the other States of Germany, nine in Austria, two in Switzerland, one in Belgium, and one in Russia. Besides these there were 191 new names proposed and passed as members at the meeting, bringing up the total number of members to 736. This must be regarded as an extraordinary success, considering that the society has been in existence barely four weeks. The meeting then proceeded to the election of its officers for the year, and as the gentlemen elected are among the most eminent, practical, and theoretical electricians of Germany, it may not be out of place if we here give their names. The council consists of the following members:—First President, Dr. Werner Siemens; Syndic, Dr. Fischer; First Secretary, Professor Dr. Neesen; Second Secretary, Herr Hoffman; Treasurer, Herr Conrad (Director of the Mint); Bookkeeper, Herr Vogel. The general committee consists of the following gentlemen:—Prof. Dr. Kirchhoff, Herr Streckert, Prof. Dr. Förster, Prof. Wiebe, Prof. Dr. Paalzow, Herr Bensen, Dr. Serlo, Herr Wedding, Colonel Kessler, Herr Budde, Herr Elsasser, Herr Sachse, Herr Busse, Dr. Brix, and Dr. Fröhlich, all resident in Berlin. The other members are Prof. Dr. Weber, of Göttingen; Prof. Dr. Neumayer, of Hamburg; Prof. Dr. Rühlmann, of Hanover; Herr Gerwig, of Carlsruhe; Prof. Dr. Carl, of Munich; Prof. Dr. Zetzsche, of Dresden; Dr. Schellen, of Cologne; Prof. Dr. G. Wiedemann, of Leipsic; Herr Kohlfürst, of Prague; Prof. Dr. Kohlrausch, of Würzburg; Prof. Dr. Clausius, of Bonn; Herr von Gumbart (Director of Bavarian Telegraphs), of Munich; Prof. Dr. Rosenthal, of Erlangen; Prof. Dr. Vogel, of Potsdam; and Herr Fein, of Stuttgardt.

The routine business having been concluded, Dr. Werner Siemens commenced his address on Electric Railways and Electricity as applied to Locomotion, the delivery of which, though occupying nearly two hours, was followed by the numerous audience with great interest from beginning to end. The following is a summary of the most essential and interesting points dealt with in the address:—

Beginning with a reference to the great extension the practical applications of electricity had undergone since the invention of dynamo-electric machines, the speaker said that formerly the principle had prevailed that we must not expect electricity to do any heavy work, and that we could only employ it to advantage as a messenger for the rapid transmission of messages and signals and similar purposes. But this state of things had recently been completely changed. By help of the dynamo-electric machine we were now in a position to produce electric currents of any strength or tension we desire, by applying active labour or force, and we are able to employ those currents themselves for the performance of work. The committee of this society, the first which had been formed to deal with the whole field of the practical applications of electricity (or electro-technics)—a society whose birth was so nearly contemporaneous with this great extension of the field of practical electricity—had accordingly considered it advisable that the first subject of discussion should be the dynamo-electric machine, and especially its application to the conveyance of commodities, &c. The speaker then explained at length why the earlier methods and means of producing electric currents, such as the galvanic battery, the thermo-column, and magnetic inductors, were inadequate. The first was too costly and inconvenient in maintenance and management. The currents produced were too dear, as was plain from the fact that galvanic batteries burn zinc in acids, and this was a far dearer kind of fuel than coal which was burnt with oxygen in the air. The thermo-batteries had recently, it was true, been constructed so as to produce strong currents; but they too had turned out unsuitable, as they presented too much internal resistance and were not durable enough. In explaining the third source of electric currents—the induction machines—the speaker entered into the principles of induction as discovered by Faraday, and described the construction of the magneto-electric machines and their gradual improvement up to the Alliance and Wilde machines, with which the electric light could at length be produced. Magneto-electric machines, however, had the great drawback that steel magnets are susceptible of but comparatively little magnetism, and that their magnetism increases in very much smaller proportion than the mass of the steel employed. Moreover, large steel magnets by degrees lose a large portion of their magnetism. For the production of very strong currents, therefore, magneto-electric machines were likewise not practically applicable, since they would occupy too large a bulk, and for this reason show too much resistance.

Now, the dynamo-electric machine contains, instead of steel magnets, only electro-magnets, which could be magnetised twenty to fifty times as strongly. It can, therefore, when only of small size, produce very powerful currents, and was free from the weaknesses of steel magnetism. In the autumn of 1866 the speaker had been led to the principle at the foundation of the dynamo-electric machine by the well-known phenomenon which Jacobi, of St. Petersburg, in particular, had proved to be a necessary one, that every electro-magnetic machine, that is to say, every machine intended to produce force by the electric current produces a strong counter-current, which increases with the velocity and considerably diminishes the current produced in a state of rest by the active battery. Theory teaches that the direction of this counter, or reverse current, depends on the direction of rotation in the machine. If, then, by external force we turn an electro-magnetic machine of any construction in a direction opposite to that in which it moves on account of a current running through it, the result

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is not a weakening, but an augmentation of the force of the current of the battery. This has in actual practice been completely verified, and it has even been discovered that to set the thing going does not require any battery at all, as the magnetism remaining in the iron is sufficient, after a few revolutions, to produce currents of such strength that we have to check the velocity, or to interpose resistances in order to meet the danger of the machine being destroyed by the too great heating of the encompassing wires by the current. At the time when he first explained, before the Berlin Academy of Sciences (on the 17th of January, 1867), the principle of what he had named the "Dynamo-Electric Machine," he called attention to the fact that, through this machine, the spell had been broken which hitherto had made it appear that electricity was useful only for the production of weak degrees of force. The applications of the dynamo-machine, which he had planned, and frequently reported on at that time, for the transmission of force, and especially for the electric railway, were, however, not capable of being realised then, inasmuch as a disturbing phenomenon, up to that period unobserved, had made its appearance in the fact that with very rapid changes of poles the iron becomes heated. The dynamo-electric machines which he had at that time constructed for the production of the electric light, were accordingly obliged to be constantly cooled with water to prevent them burning. Since then, very material improvements had been made in the dynamo-electric machine by MM. Paccinotti, Gramme, and Von Hefner-Alteneck, the last-mentioned gentleman being one of the head engineers in his own firm of Siemens and Halske. Through these improvements, the application of electro-magnets, with changes of pole, and the reversal of the direction of the induced currents had been entirely avoided. The speaker here explained the difference between the Hefner and the Gramme-Paccinotti machines, and showed that the former possessed the advantage of developing less resistance with an equal power of induction, a point which in the transmission of force is of great importance. Other methods of construction which had recently been made known are, in the main, copies, without any essential modification, of either the Paccinotti-Gramme or of the Hefner machines.

The speaker now passed on to the illustration of the application of the dynamo-electric machine to the purpose of transmitting force. Referring to a formula he had set forth in his paper on "Electricity in the Service of Practical Life," he said that only theoretical importance was to be attached to that formula, since the dependence of the degrees of strength of the current on the velocity of rotation had been essentially modified by the fact that the correct position of the rubbers or rubbing springs through which the currents of the two halves of the folds of the rotating Paccinotti ring or the Hefner cylinder are conducted unitedly forward is dependent both on the strength of the current and on the velocity of rotation, and that every time they are compelled to shift from the normal position, the induction-value of the machine is diminished. The current of a dynamo machine, therefore, increases, not as theory would show—that is, with the third powers of the velocity of rotation, but in a far smaller proportion, varying according to the variously-constructed machines. This is especially noticeable in cases of great velocity of rotation and strong currents, as here the effect is aided by the circumstance that the electro-magnetism in the iron has a maximum, and approaches it in cases of strengthened currents. This, however, was of no essential moment so far as the further explanations and deductions were concerned. If we conductively connect two dynamo machines with each other, and set one of them rotating at a certain velocity by help of some motive force, the current thus produced must run through the other machine. This now becomes an electro-magnetic machine, and begins to rotate; and it does so in the reverse direction to that in which it must be turned as a dynamo-electric machine. It now itself produces a current which has the opposite direction to that in the dynamo machine, and so weakens the latter current. If the machine which is turned had no resistance of any kind to overcome, its velocity must go on increasing till it produced a counter current just as strong as the current of the dynamo-electric machine. No further current would then pass through the conductor, and the dynamo machine would no longer require any noteworthy force in order to turn it. If now we give the electro-magnetic machine some work to do, the velocity of its rotation will diminish. Thus the counter current it produces will become smaller, and there will now arise a current which corresponds to the difference between the two velocities, and which will perform the labour imposed. From these considerations it follows that the ratio of the work applied to the dynamo machine to the work done by the electro-magnetic machine cannot be a fixed ratio, but must depend on the velocity of rotation of the two machines. The numerous experiments which have been made, and which were represented in diagrams and tables, exhibited by Dr. Siemens to the meeting, completely proved this fact. In the case of the two larger machines employed in the experiments, the force transmitted amounted to about 50 per cent. with 600 revolutions, and to about 60 per cent. with 700 revolutions of the dynamo machine. A nearly equal ratio was found when two smaller machines were inserted parallelwise in the circle of the current of the larger dynamo machine. The sum of the work of the two then amounted to about 50 per cent. of the expenditure of labour for the larger machines.

The speaker now proceeded to consider the application of electricity to the purposes of conveyance or carriage. That this is practicable had been shown by the first electric railway ever constructed, viz., that which had been exhibited by his own firm in the Berlin Industrial Exhibition last year, and which, in the course of the summer, had carried 100,000 persons at a speed of three to four mètres per second. This had been effected by two medium-sized dynamo-electric machines, one of which had been kept by an exhibition machine in constant rotation, while the other was mounted on a small carriage frame, the wheels of which it turned. The electric current had been conducted to the locomotive through a third rail laid down in the middle of the line on wooden supports, and had been transmitted through metallic brushes from the rail to the encircling wire of that dynamo-electric machine which was acting as an electro-magnetic machine. The stream had been conducted in the reverse direction through the wheels and rails of the line itself. The insulation, though very defective, proved sufficient, even in wet weather, for this line, which was about 300 mètres in length. With longer lines, no doubt, a better insulation would have to be provided. But it may be taken as demonstrated that electricity can with advantage be employed for the conveyance of burdens on rails. Only about one half the labour expended was actually utilised in the form of useful work done; but this was by no means an unfavourable proportion. The cost of heating the best steam locomotive was probably always about double as much as that of the best constructed stationary steam engines with boiler properly arranged, supposing the work done by each to be equal. Probably with time the proportionate cost of firing would become more favourable with electric power than with steam locomotives. Notwithstanding all these things in its favour, the lecturer did not believe that the electric locomotive would ever be able to dispute the palm with the steam locomotive upon the great arteries of traffic of our times, that is, upon the railways. This would no more be the case than that electric lighting, however the Americans might boast, should wholly drive out gas lighting. But in both cases there is a large field which would be occupied by electricity. In the case of railways, this would be found in the relay service, to enable steeper gradients or ascents to be surmounted than were now possible; and again in the service on short lines, like that in the Berlin exhibition, in large work yards, docks, and mines, and similar places; further, in the elevated railroads in cities like that in New York; and, lastly, in the rapid conveyance of packets, and especially the mails for the post, by means of covered, narrow-gauged lines. The speaker then explained his project of an "Electric Post," which was illustrated by a number of large diagrams hanging round the hall. The walls of the Electric Post Railway were to be of iron plates two mètres in height. The arrangement would be open below, and closed at the top, the covering being made so as to be capable of being taken off in pieces. By means of angle iron rivetted on the plates, the structure is fixed at regular intervals of 15 mètres on wooden traverses or crossbeams which are supported by iron columns of suitable height upon the ground. To support the very light rails, light wooden or glass sleepers are fastened at suitable distances on the lower edge of the iron plates forming the walls. One of the rails is at frequent intervals connected for the purpose of conduction with the iron plates, while the other is similarly connected with each of the iron columns. On the rails run small four-wheeled carriages, one of the axles of each being formed by the rotating cylinder of a small Hefner dynamo-machine. The wheels of both sides are insulated from each other, and are the means of directly conducting the electricity from the machine to the rails, which are also insulated from each other. The hinder part of the carriage is fitted up to hold the letters, &c., to be conveyed. Owing to the lightness of the carriage, it will be propelled with great speed by a dynamo-machine placed at any point of the line between the rails. Owing to the little resistance offered by the iron covering, and the still smaller resistance of the reverse conduction through the earth, it will suffice to place a dynamo machine for the production of the current at intervals about 20,000 to 30,000 mètres apart, and a carriage loaded with post bags could then be despatched every five or ten minutes. The speaker pointed out the use which a cheap arrangement of this description would be for the rapid conveyance of mails, it being adapted for great distances, while the tubular post is only applicable to short distances. Another

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application of electric conveyance which would be very useful, and, indeed, necessary for the city of Berlin, was then described by the speaker. This is the elevated electric railroad, which was also illustrated to the audience by a number of large diagrams. Berlin required additional means of internal conveyance. No underground railways could be built owing to the great height of the ground water. The excessive street traffic was becoming intolerable, and it was not practicable, owing to the great value of the large houses and other causes, to build lines above ground except in the streets. Hence, the elevated railroads or railways on columns were the only expedient. They would have to be built too massively for Berlin streets if they were to be worked by steam locomotives as in New York, and besides the nuisance of the noise they would create, they would greatly disfigure the appearance of the streets of the city. On the other hand, electric railroads on columns could be built of a light and even elegant description, and would carry passengers rapidly and noiselessly over the traffic of the streets. The outlay for construction would be about 150,000 marks, or £7,500 per 1,000 mètres. On such an elevated electric railroad of, say 10,000 mètres in length, carriages accommodating 15 persons could be started every five minutes, while an average of five persons on each journey would, according to Dr. Siemens' calculations, make the enterprise a paying one. As Berlin was the birthplace of the dynamo-electric machine and the electric railway, the speaker hoped it would be the first city to adopt elevated electric railroads.

In conclusion, the speaker touched on the application of electric power to the propulsion of ordinary trains on the railways, and dwelt more particularly on the assistance it could render to steam locomotives in surmounting steep ascents. This could be done, in a manner similar to that which was exhibited on a small scale in the Berlin Exhibition, by means of an insulated conducting rail, which, however, would be better placed alongside or even above the train, on insulating supports; or it might be effected by help of a conducting cable of copper wire, resting on glass supports, and raised by the carriage provided with the propelling electrical machine, in a way similar to the cable in chain navigation, through rollers suitably placed, and by the levers of the supports, the cable being laid on them again after the carriage has passed. The rollers then form the media of contact between the insulated conducting cable and the electric machine.

THE ANGLO-AMERICAN TELEGRAPH COMPANY.

The report states that the total receipts from July 1st to December 31st, 1879, including a balance of £11,300 brought over from the last account, amount to £397,426, being an increase in the traffic receipts as compared with the corresponding period last year, of £91,731. The total expenses of the half-year, including income tax, repair of cables, &c., as shown by the revenue account, amount to £59,766. The directors, under the powers conferred upon them by the articles of asssociation, have, before declaring the net profits, set apart the sum of £140,000 to the renewal fund, leaving a balance of £197,660. One quarterly interim dividend on the ordinary stock, at the rate of 6 per cent. per annum free of income tax, was paid on the 1st November last, absorbing £105,000, leaving a balance of £92,660, out of which the directors recommend the proprietors to declare a final dividend of 1¼ per cent., free of income tax, amounting to £87,500, making a total distribution for the year ended the 31st December, 1879, of 5 per cent. upon the consolidated stock of the company, 6 per cent. upon the preferred ordinary stock, and 4 per cent. upon the deferred ordinary stock; and leaving a balance of £5,160 to be carried forward to the next account. The cables laid by this company in 1873 and 1874 are in good working order and condition. The Brest-St. Pierre cable laid in 1869, and reported broken in the last half-yearly report, was repaired by the company's ss. Minia, on the 10th August, 1879. The short section of the same cable, between St. Pierre and Duxbury has again been interrupted, but the company's repairing ship being in the neighbourhood when the fault occurred, the restoration of communication was speedily effected. The Minia has also been engaged in the repair of the company's inter-island cables, between Newfoundland and a point near Cape Breton, N.S., some of which cables, the directors regret to report, now require renewal. The cable laid in 1867 by the New York, Newfoundland, and London Telegraph Company, and taken over by this company in 1873 is worn out, and has been abandoned. The cable laid by the same company in 1872 has been constantly under repair, and cannot be relied upon. The directors have decided to replace these cables in the course of the coming summer, by a cable of much heavier type, with largely increased carrying power, which, added to the lines now existing, will provide for the necessary requirements of the traffic. As announced in the last half-yearly report of the directors, an additional cable will be laid this year between Ireland and Newfoundland to replace one of the cables which have been abandoned. Preparations are now being made to effect a re-survey of the Atlantic, in order, if possible, to find a route for the new line, which will render it less liable to interruptions. Experiments have been proceeding for some time past, with a view to the adoption of a more permanent description of outer covering for the better protection of deep sea cables; the precise form which this new outer covering will take has not yet been decided, but as the experiments thus far have been successful, the directors have every reason to believe that they will ultimately result in a greatly improved type of cable. As the whole of the large outlay to be incurred for the new cable have to be borne by the renewal fund, the directors, before recommending the declaration of a dividend, deemed it absolutely necessary to place a large additional sum to the credit of that fund, in order to meet the expenditure which has now become imperative

TELEGRAPH SHARE LIST.

Companies.	Closing Prices Feb. 4.		Business Done Week Ending Feb. 4. Highest.	Lowest.
Anglo-American Ordinary	62½,	3	63¾	61
Do. "B"	89,	½	89¾	87¼
Do. "A"	36½,	7	37⅞	35
Brazilian	7 15-16,	8 1-16	8 1-16	7⅞
Cuba	8¾,	9¼	9¼	9¼
Do. Ten per Cent. Preference	16½,	17	—	—
Direct Spanish	1¾,	2¼	2¼	2⅛
Do. Ten per Cent. Preference	11,	¼	11¼	11
Direct United States x d. Jan. 30	11⅝,	¾	12¼	11¼
Eastern	9,	⅛	9⅜	8⅞
Do. Six per Cent. Debenture	103,	6	—	—
Do. Five per Cent. do. x d. Feb. 2	101,	3	102¾	102¼
Do. Six per Cent. Preference	11 15-16,	12 1-16	12	12
Eastern Extension	9 1-16,	3-16	9 3-16	8 15-16
Do. Six per Cent. Deb. x d. Feb. 2	104,	7	—	—
German Union x d. Jan. 30	8¾,	9	9⅛	8⅞
Globe Telegraph and Trust	5 11-16,	13-16	5⅞	5 9-16
Do. Six per Cent. Preference	11⅜,	⅛	11⅝	11⅜
Great Northern	9	¼	9¼	9 1-16
Indo-European	23,	4	—	—
Mediterranean Extension	3,	½	3¼	3¼
Do. Eight per Cent. Preference	10½,	11	—	—
Reuter's	10,	11	10⅜	10⅜
Submarine	235,	40	235	235
West India and Panama	1⅞,	2	2	1⅛
Do. Six per Cent. Preference	8,	¼	8	7⅞
Western and Brazilian	7¾,	⅞	7 15-16	7 1-16
West. Union Seven per Ct. 1st Mt.	120,	125	—	—
Do. Six per Cent. Sterling	105,	7	—	—

TRAFFIC RECEIPTS FOR JANUARY, 1880.

Companies.	Jan. 1880.	Jan. 1879.	Incrse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	3,200 estd.	3,043	157	—
Direct Spanish Telegraph Company	—	—	—	—
Direct United States Telegraph Company	—	—	—	—
Eastern Telegraph Company	48,887	39,226	9,661	—
Eastern Extension Telegraph Company	28,009	24,695	3,314	—
Great Northern Telegraph Company	17,280	13,876	3,404	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—

ADDRESSES.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

PETER BROTHERHOOD, Engineer, 56 and 53, COMPTON-STREET, GOSWELL-ROAD, E.C.
Specialities—Patent 3-Cylinder Engines (Silver Medal, Paris), as used by Siemens, Gramme, and Wilde for driving Electric Machines.

RANSOMES, SIMS, and HEAD, Orwell Works, IPSWICH.
Specialities—Portable and Stationary Engines, fitted with patent governors, as tried in the electric lighting experiments on the Thames Embankment.

ABBOTT and Co., NEWARK-ON-TRENT.
Specialities—The "Standard Size" Vertical Cross Tube Boilers. Illustrated catalogue, giving every detail of a variety of Boilers, 2s. 6d., post free.

CARBON ELECTRODES COMPANY. Works: 39, COMMERCIAL-ROAD, EAST.
Specialities—Carbon Rods of all sizes for Electric Lighting. Also, Plates and all other Moulded Carbon Goods. List of prices on application.

M. THEILER & SONS, Telegraph Instrument Manufacturers, 86, CANONBURY-ROAD, N. Works: ALWYNE-LANE, N.
Specialities—Morses, Polarised Relays, Saunders' Curb Keys, Type Printers, Recording Sounders, Duplex Apparatus (Theiler's Patent).

HOOPER'S TELEGRAPH and INDIA RUBBER WORKS, MITCHAM and MILLWALL DOCKS.
Contractors for the Manufacture and Laying of Submarine Telegraph and Torpedo Cables. Manufacturers of Hooper's celebrated Insulated Core. Printed reports on application. Offices: 31, LOMBARD STREET, LONDON, E.C.

THE BRITISH ELECTRIC LIGHT COMPANY (Limited), 41, PARLIAMENT-STREET, WESTMINSTER, and 17, WATER-STREET, LIVERPOOL.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

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SLIP

THE ELECTRIC LIGHT.—The use of this means of lighting has obtained favour at the works of the New Mersey Tunnel.

RUSSIA.—Katkoff, the editor of the *Moscow Gazette*, has been authorised to establish a telegraphic agency. "*Les extremes se touchent.*"

THE ELECTRIC LIGHT.—"The Electric Light; and its Application to Military Purposes" is the title of a new Russian work, by M. Tchikoleff.

THE CUBA SUBMARINE TELEGRAPH COMPANY.—The seventeenth ordinary meeting of this company will be held next Wednesday, 18th inst., at the offices, 61, Old Broad-street.

CASSELL'S TECHNICAL EDUCATOR.—The current number contains a continuation of the articles on "The Electric Telegraph," by J. M. Wigner, B.A., B.Sc., as well as a number of other articles on various subjects.

MAIDSTONE.—In order to compare the light of gas and that of electricity, a gentleman has offered to provide the apparatus necessary to illumine the bridge. It is hoped the light will shortly be exhibited.

LECTURES ON THE TELEPHONE.—It is interesting to find that attempts are made by local societies to disseminate information on scientific subjects. Thus at Southminster, under the auspices of the Reading Room Committee, a lecture was delivered in the National School room by Mr. G. E. Pritchett, F.S.A., on the telephone and microphone. The chair was occupied by Mr. John Kemp, of North Wycke. Several specimens of the telephone and microphone were exhibited, and various experiments were made.

TRANSMISSION OF MOTIVE POWER BY ELECTRICITY.—At Shaw's Water Chemical Works, Greenwich, a neighbouring waterfall furnishes the power to drive a circular saw, a turning lathe, and a vertical boring machine. Two Siemens machines and a water turbine are employed. The turbine is driven by the fall, and one machine is driven by the turbine. The current from the latter is conveyed to a second machine in the workshop 150 yards distant, and keeps the latter going. From this machine the tools above mentioned are driven by means of belting.

THE SOCIETY OF TELEGRAPH ENGINEERS.—A SUGGESTION.—It is hardly the aim and object of a learned society to make its journal an advertising medium. The Royal and the Chemical do not descend to trade—the Geographical does. More is the pity. Again, why accept papers to be read which are old, and have already been printed, *e.g.*, "A New Method for Localising a Contact of Two Line Wires," by F. Cardarelli. This paper was published in 1878, in *L'Elettricista*, and translated for *The Electrician* at least eighteen months before it was read as original before the society.

THE ELECTRIC LIGHT AT PORTSEA.—The lamps at Portsea are much admired, the light being so soft and powerful at the same time that it is very agreeable to the eye. The motive power is an 8 horse Otto horizontal gas engine, which drives a powerful Gramme machine, the magnets of which are excited by a smaller machine of the same kind. The gas engine consumes 125ft. of gas per hour, and the only other expense is that of the Jablochkoff carbon candles, four of which last six hours, one only being burnt in each lamp at a time. The candles at present cost fivepence each, but will shortly be supplied at a far cheaper rate. The firm guarantee that each lamp gives out a light equal to 500 candles.

ELECTROLYSIS IN SODA MANUFACTURE.—M. Merle, the manufacturer of the chemical works of Merle and Co., has erected electrical machines, which are employed to eliminate, by means of electrolysis, the whole of the iron and other metals, such as lead and arsenic. The separation of these metals is effected very rapidly, in large quantities, at a comparatively small cost. The soda crystals, which are obtained from the concentration of the leys are very white, and well adapted to the bleaching of fabrics previous to drying. The manufacture of soda crystals and caustic soda, in the south of France, is very difficult, on account of the high temperature, which makes the mother liquors too rich in carbonate of soda.

ELECTRICITY OF MACHINE MADE PAPER.—This phenomenon was first described by Hankel in *Pogg. Ann.*, lv., 477. On leaving the last pair of pressing rollers the paper is highly negative. The paper on the reel is electrified, and notably so when the reel is large. When the paper is cut off from the reel, and the sheets pulled apart, it is stated that frequently brilliant sparks pass. This electricity arises merely from the heating of the paper and its compression, as no friction takes place while the velocity of revolution of the rollers is the same. In *Pogg Ann.*, lxviii., 159, mention is made of *Schönbein's* electrical paper, employed by him in the construction of an electrical machine. Can any reader give a description of this paper?

ELECTRIC LIGHTING OF MINES.—An extremely useful application of the electric light has been made to the lighting of the lower workings in the anthracite mines in Pennsylvania. The lamp employed for the purpose is that of Brush, which is at present one of the most extensively used in America, and is used for street lighting in many parts of Boston and New York. The dynamo-electric machine is erected on the surface, near the engine, and is capable of maintaining six lights on the same circuit. Any one of these lamps can be removed without interrupting the current, and may be carried along the workings as required. The conducting-wire leading from the machine is carried down the shaft, along the galleries to the different lamps, and back to the machine.

SINGULAR ACCIDENT AT LEEDS.—A singular accident is reported from Leeds. A telegraph wire was being put up for the Corporation Gas Works, York-street, Leeds, by Messrs. Blakey and Emmett, of Halifax. The wire was carried across the North-Eastern Railway, near Marsh-lane Station, but before it had been finally fixed an engine came up and caught the wire, which was broken by the sudden and severe strain upon it. One end of the wire whirled round some chimneys, portions of which it brought down, and fell into Brussels-street, where a man named John Levisedge, residing in Grape-street, Hunslet, was caught in its coils before he had the chance of escaping, and was so severely injured that he had to be removed home in a cab, and to receive medical assistance.

TELEPHONES.—M. Doumoutier would make telephones consisting of a horse shoe magnet, one face of which serves to receive the telephone, the other face to receive the call. His call is constructed of a magneto-electric apparatus formed of two bobbins turning in front of the magnet; the current is collected by means of a commutator and sent into any ordinary bell arrangement. The telephone is applied to the other face of the magnet. He fixes the bobbin of the telephone flat on one of the poles of the magnet, the other pole carrying a piece of soft iron touching the bobbin. This

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piece of soft iron carries a spiral iron wire surrounding the copper wire of the bobbin. The other end of the spiral wire reaches to the level of the bobbin at the height of the nave in such a manner as to act with it on the membrane.

ELECTRICITY.—WHAT IS IT?—Whilst this question is being discussed in our columns, we may point out that our contemporary, *La Lumière Electrique*, has devoted two articles to the "Analogy between Electric Phenomena and Effects Produced by Mechanical Action," *v.* Nos. 1 and 3 for 1880. In the latter the contention that electricity is "A movement purely mechanical of ponderable matter" is strongly argued. The last number of *The American Journal of Mathematics* contains an interesting paper on a "New Action of the Magnet on Electric Currents," by E. H. Hall, which has some bearing on this question, and which we intend to reprint as soon as we can spare the required space. Mr. Preece in his inaugural address specially directed attention to this subject, and we may take an early opportunity of commenting on the whole subject.

INDO-EUROPEAN TELEGRAPH.—It appears from the traffic returns of the Indo-European Telegraph Department for Nov., 1879, that the total rates on Indian and trans-Indian messages transmitted to London from Kurrachee during Nov., 1879, were approximately £4,267. This amount—subject to adjustment on receipt of the message returns from India and Persia—has been credited to the Common Purse Account, and that account has been provisionally debited with £6,150, representing the shares of the Indo-European Telegraph Department in the total receipt by all lines. The actual earnings of the line are higher than in the corresponding months of the three preceding years, but the amount is not quite so high as it was in October last. No delay took place in the average time occupied in the transmission of messages from India to England *viâ* Russia and Turkey.

NEWSPAPER TELEGRAPHY IN GERMANY.—In order to show what is done in Germany in the way of transmitting long despatches to the newspapers, the *Cologne Gazette* of Friday, the 6th inst., says:—"Yesterday (the 5th), between 1 p.m. and 9:45 p.m., the telegraph, working with two wires, one of which, however, did not commence till 4 p.m., brought us from Berlin alone 1,695 lines, containing more than 17,000 words, an achievement which we think far surpasses the celebrated performances of a similar nature in England, and which affords the most splendid testimony at once to the high stage of advancement our telegraphic system has attained, and to the excellence of the officials employed in this service. In judging of the performance it must be borne in mind that the telegraph clerks had to read manuscripts or handwritings of the most varied description, and that the greater part of the work had to be done by gas or artificial light."

THE MICROPHONE.—The documents referred to in the following memorandum will receive our future attention:—"The undersigned respectfully submits to your attention the enclosed copies of documents which were filed by him in the Patent Office of the United States, and which are intended to prove that the principle of the instrument known as the 'Microphone,' and the action of which depends upon the variation, 'by sound waves,' of contact pressure at a point of contact between two electrodes, was used, described, and claimed by him some time before the so-called Microphone was presented to the world. The undersigned has repeatedly since 1877 endeavoured to place his own claims before the public; but as, for reasons unknown to him, no attention was paid to them, he has waited for some official endorsement by the United States Patent Office, as may be seen from the patent just granted to him; and he takes this step so as to submit the question of priority directly to the decision of his co-labourers in science.—EMILE BERLINER."

THE REFLECTING GALVANOMETER.—M. Gaiffe has adopted a bifilar suspension for this instrument, and is thereby said to reduce the scale-error 1 per cent. of the total deflection. By scale-error we mean the disproportion between the deflections on the scale and the currents they represent, a disproportion which increases with the angle of deflection. The cause of the error, as is well-known, consists in the fact that the angles of deflection of the magnetised needle are doubled by the reflection of the mirror, and consequently it is not the tangents of the real angles of deflection that one reads on the scale, but the tangents of the doubled angles. Though it may be assumed without much error that the tangent of double a very small angle is twice that of the single angle, the case is different for large angles; and, although the deflections of the needles of this class of apparatus are generally limited to about eight degrees, the reading is sensibly exaggerated even at the end of this range. M. Gaiffe essayed to remedy this defect by employing a fine platinum wire, but had ultimately to adopt a double silk suspension.

SEDLACZEK AND WIKNLILL'S LAMP.—These gentlemen propose an electric lamp in which the two carbon electrodes are carried by two pistons or floats contained in two closed vessels filled with liquid in communication with each other, the relative heights of the liquid in the vessels and the weight of the pistons and arms projecting therefrom carrying the carbons being so proportioned that the piston carrying the upper carbon will tend to descend in its vessel, causing the liquid to flow therefrom into the other vessel, and thus raising the second piston with the lower carbon. The communication between the two vessels is governed by a cock, so actuated by the current passing to the carbon electrode, that when such current increases in strength, owing to a too near approach of the carbons, it causes the cock, valve, or slide to cut off the said communication, thereby preventing the further approach of the carbons, until by their burning away and the consequent lengthening of the voltaic arc the current becomes sufficiently decreased to allow the communication between the two vessels to be re-established.

DYNAMO MACHINES IN TELEGRAPHY.—Last year M. Schwendler, in India, indicated in a paper which, perhaps, has not received the attention which ought to have been given it, how dynamo machines might be used for telegraphic purposes. We now find that America is to be credited with the invention, which, according to the *Scientific American*, is due to the ingenuity of Mr. S. D. Field, of San Francisco. Our contemporary tells us that 14,300 gravity battery elements, and 4,600 bichromate of potash elements are to be replaced by Siemens' machines. It says:—"All efforts formerly made in this direction sought to accomplish the object by using a single high tension machine. The potential is now obtained by connecting one commutator brush of one machine with the brush of opposite polarity of the next, and so on, and a current of any desired potential may be had by taking it off from the different machines in the series. A current taken from the first machine in the series will have a low tension; that taken from the second machine will have a higher tension, and so on. The electromotive force of the first machine in the series is 50 volts; in the second, 100 volts; in the third, 150 volts; in the fourth, 250 volts." In 1873 the Western Union Company sent 14,456,832 messages,

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at a cost of 6,575,055 dollars; in 1879, 23,070,106 messages were sent at a cost of 6,160,200 dollars. In 1869 the cost of battery per mile of wire was 117·1 cents, in 1879 it was 34·1 cents. This company has about 200,000 miles of wire.

Carbon as an Electro-Positive.—In the second edition of the "Traité Elementaire de la Pile Electrique" of M. M. A. Niaudet, the author, after pointing out that zinc is economically more advantageous than aluminium, or any other electro-positive in all aqueous electrolytes hitherto experimented with, adverts to the fact that magneto or dynamo-electric machines are far more economical still as generators of electricity, since they utilise coal, which is the cheapest fuel for the production of heat or energy. Referring then to the question whether carbon cannot be utilised directly in the production of electricity, he describes the experiment of Bequerel, in which a platinum crucible, containing fused chlorate or nitrate of potash, is attached to one terminal of a galvanometer, whilst a piece of gas carbon is connected to the other terminal. The extremity of the carbon being heated to redness, a powerful current is produced by immersing it into the fused salt; the direction of the current indicating that the carbon forms the negative pole or positive element. In other words, the carbon here takes the place of zinc. Without being aware of the previous experiment, M. Jablochkoff fused nitrate of soda in a crucible of cast-iron, using a fragment of carbon as above; the iron was not attacked, whilst the carbon was consumed at the expense of the oxygen contained in the nitrate. Here, again, the carbon takes the place of zinc; whilst the iron constitutes the negative element. It is pointed out that in this case the relative position of the electrodes is inverted; for, if the nitrate be dissolved in water, the iron then corresponds to the zinc, whilst the carbon constitutes the negative element.

Dividing the Electric Light.—Some time ago Mr. W. H. Preece gave the formula $H = \frac{E^2 l}{(\rho + r + l)^2}$ for the quantity of heat distributed to an incandescent wire, where ρ is the resistance of the battery, and r and l the resistances of the wires and the lamp. For n wires in series, $n\,l$ must be put for l, and for n wires in multiple arc $\frac{l}{n}$ must be put for l. In either case H is a maximum when the resistance of the lamp system equals that of the rest of the circuit. Mr. Preece argues from this that the amount of heat liberated in each lamp varies inversely as the square of the number of lamps; but, though this is true for the two cases taken by him, it has been pointed out by Mr. P. E. Nipher, of St. Louis, that, if there are n lamps arranged in n' parallel circuits, in each of which there are n'' lamps, the previous equation becomes

$$H''' = \frac{E^2 \frac{n''}{n'} . l}{\left(\rho + r + \frac{n''}{n'} l\right)^2},$$

an arrangement rendering it always possible to get the condition which makes H''' a maximum whatever n may be. If, for example, $\rho + r = \frac{n''}{n'} . l$ we shall have

$$H''' = \frac{E^2}{4\,(\rho + r)},$$

or the total heat in n lamps is independent of the number of lamps. The heat generated in each lamp will then vary inversely as the number of lamps.

Telephone Communication in Edinburgh.—Two companies have lately opened offices in Edinburgh for the purpose of developing telephonic communication for business purposes. By the Telephone Company (Limited), whose Edinburgh offices are in Frederick-street, the system has been extensively tested in London, Manchester, Liverpool, and elsewhere, the telephone used by them in every case being the patent of Professor Bell. In carrying out their plan of exchanges the Company undertake that every person or firm becoming subscribers shall have, for an annual payment of about £20, a wire provided between his premises and the central telephone station in the city, as well as the requisite instruments for communication. In the central station these wires are brought together on a large switch board, in front of which one of the Company's operators constantly sits during business hours watching for any signals that may be given. In every office connected with the circuit, a list of subscribers is hung; and if, on consulting this, a business man finds that another office with which he wishes to communicate appears upon it, he indicates such wish to the station, requesting that the firm in question be called and their wire put in connection with his own. This the operator, by a simple adjustment of the switch board, and what is called "plugging," or shutting off the two wires, at once effects; and the persons in two distant offices are then enabled to carry on conversation without running any risk of being overheard. A similar mode of communication is offered by the Scottish Telephone Company, whose offices are in St. Andrew's-square, and who, it is said, have about sixty instruments in use in Edinburgh and Leith. As stated in the prospectus, the difference between the latter company and that first mentioned is "that it is pledged to the use of no particular instruments or patents."

Clerk Maxwell.—An excellent non-mathematical account of the life-work of the late Prof. Maxwell is given in last week's *Nature* by his old school fellow and friend, Prof. P. G. Tait, of Edinburgh, best known to the public as the author of "The Unseen Universe" and to science as the colleague of Sir William Thomson, and joint author with the latter of "Thomson and Tait's Natural Philosophy." The writer reveals the interesting fact that in early life Clerk Maxwell chose Sir William Thomson as his master; and asserts that his clearness of mental vision was quite on a par with that of Faraday. This quality and the power of constructing a mental representation of every problem (and not any ready mastery over symbols) made him a mathematician of the highest order. The rapidity of his thinking, which he could not control, was such as to destroy, except for the very highest class of students, the value of his lectures. His books and written addresses (always gone over twice in MS.) are models of clear and precise expression; but his extempore lectures exhibited in a manner most aggravating to the listener the extraordinary fertility of his imagination. His original work began in his boyhood with a paper in the *Transactions of the Royal Society of Edinburgh*, "On Oval Curves," ere he had attained his fifteenth year. He had then been taught only a book or two of Euclid, and the merest elements of algebra. During his undergraduateship at Cambridge he developed the germs of his future great work on "Electricity and Magnetism" (1873), in the form of a paper "On Faraday's Lines of Force," which was ultimately printed in 1856 in the *Trans. of the Camb. Phil. Soc.*, but the MS. of the greater part of it was shown to Prof. Tait by the author in 1853. It is interesting to learn that his curious *nom de plume* $\frac{d\,p}{d\,t}$ = J.C.M. (James Clerk Maxwell) was suggested to him by Prof. Tait.

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ELECTRO-DYNAMIC ACCUMULATION.

THE CHRONOPHER OF MR. C. F. VARLEY, F.R.S., M.I.C.E., &C.

The recent invention of Messrs. Houston and Wright (described in the *Journal of the Franklin Institute*, and reprinted in *The Electrician*, January 17th) has been shown to be the reinvention of an apparatus designed by Mr. C. F. Varley, F.R.S., M.I.C.E., in 1859 or 1860, and applied by him in the distribution of time signals. We have received from Mr. Varley a full description of the chronopher apparatus as invented and designed by him, from which we have made the following abstract :—

The chronopher (*χρονος*, *time*, and *φερω*, *I bear*) consists of (1) a clock, to control the whole of the changes and connections; (2) various sets of galvanic batteries to supply the currents which give the signals to the various stations, and also to put in action the various relays and magnets; (3) a large commutator or switch for connecting the lines to the chronopher when time is to be transmitted; (4) two relays which give the actual time signal to the different stations; (5) two electro-magnetic switches, the use of which will be hereafter described; (6) two galvanometers to show by the deflection of the needles the passage of the currents. These various parts of the apparatus will now be separately described in detail.

I. The Clock.

The clock employed in connection with the chronopher is a well-constructed and accurate timekeeper, furnished with a double means of adjustment, by which it is regulated with the greatest ease and nicety. The pendulum consists of a rod of pine wood carrying a cylindrical bob of zinc; this bob is supported by a nut on a fine thread screw. This is an ordinary delicate adjustment, but for further and more delicate regulation the following arrangement is made :—A long spiral spring is attached to the bottom of the pendulum, and suspended by means of a silk thread to a rod which runs through the clock-case about a foot below the point of suspension of the pendulum itself. The circumference of this rod is exactly half an inch, and it is terminated outside the case by a milled nut furnished with an index or pointer in front of a circular disc divided into 100 equal divisions. It is therefore manifest that when the rod is turned, the silk thread will be either wound or unwound, and the spiral string tightened or loosened, each of the divisions on the disc being equal to $\frac{1}{200}$ of an inch of the silk thread. The clock by the first adjustment is made to go slightly slow, say at the rate of ten seconds per day; the spiral spring being tightened has a tendency to accelerate the pendulum, and thus brings the clock into exact and perfect time. It has been found by experiment that an alteration of $7\frac{1}{2}$ divisions either way will alter the clock at the rate of one second in twenty-four hours. Nothing therefore can be more easy than to regulate the clock by this arrangement, and the great advantage of it is that the pendulum need never be touched, nor its regular motion interfered with, an advantage which anyone who has had to regulate accurate clocks will at once appreciate. The clock in addition to the ordinary wheels common to all clocks of the same kind, has a wheel revolving once in twenty-four hours. On the same axle as the twenty-four hour wheel, and revolving with it, are two solid discs or wheels of ebonite; the front ebonite wheel has two notches cut in it, corresponding to 10 a.m. and 1 p.m.; the back ebonite wheel has one notch only, corresponding to 10 a.m. These ebonite wheels will hereafter be called respectively the front and back twenty-four hour wheels. On the same axle as the hour wheel, and revolving with it, are two similar, but somewhat smaller, ebonite discs. In each of these discs is inlaid a small contact piece of platinum, which is in metallic connection with the frame of the clock through the axle. These ebonite discs will hereafter be called respectively the front and back hour wheels. In the back hour wheel is fixed a small pin, the use of which will be explained further on. On the same axle as the wheel which carries the scond hand is fixed a small metallic projecting piece about half an inch long, which is tipped with gold; this piece is also in metallic connection with the frame of the clock through the axle. Below the seconds hand is fixed a double metallic lever, shaped like the letter V; the lower end of this lever is made sloping, and hangs down between the hour wheels; the upper end carries a small gold spring, which in the normal state of the clock hangs about one inch below the axle of the seconds hand. This lever will hereafter be called the seconds lever; it is so arranged that when the pin in the back hour wheel touches its lower end the gold spring is so raised that the next revolution of the seconds hand brings the gold-tipped piece into contact with it. Above the twenty-four hour wheel, but insulated from each other and from the clock, are two other V shaped metallic levers. The lower ends of these levers rest on the edges of the twenty-four hour wheels, and the upper ends in their normal position rest about one-eighth of an inch above the hour wheels. The front or lower of these levers which rests on the front twenty-four hour wheel is used in connection with the Newcastle time arrangement; it will therefore hereafter be called the "Newcastle lever." The other lever is used in connection with the electro-magnet in the commutators; it will, therefore, be called hereafter the "commutator lever."

II. The Galvanic Batteries.

Of these there are five separate sets.—No. 1. The copper pole of this battery is connected to the frame of the clock, and the zinc pole has a double connection, one going through the coils of the electro-magnetic switch which brings the relay into operation, and thence to the "seconds lever" in the clock; the other through the coils of electro magnet which discharges the mechanism of the commutator, and thence to the "commutator lever" of the clock. It will thus be seen that when the upper end of the commutator lever is allowed to come into contact with the platinum piece in the back hour wheel, a current flows through the coils of the electro magnet to which it is connected, attracting the armature (it being remembered that the platinum piece is in metallic connection with the clock frame). In the same way the electro-magnetic switch is brought into action whenever the gold-tipped piece on the seconds hand axle comes into contact with the gold spring of the seconds lever. The use of one battery to perform these two services never causes any inconvenience, because the contacts are never made at the same time, and one at least of the two different circuits is always disconnected.—No. 2. The copper pole of this battery is joined to the clock frame, the zinc pole to a wire which traverses the coils of the Newcastle electro-magnetic switch, and thence to the "Newcastle lever" in the clock. The platinum piece in the "front hour wheel" being in metallic connection with the clock frame, it follows that whenever the upper end of the "Newcastle lever" comes into contact with it, the Newcastle switch is brought into operation, joining the line to the relay as will be explained hereafter.—No. 3. This is a powerful battery, the copper pole of which being connected with the earth, the zinc pole is joined to the back stop of the provincial relay. This battery supplies a zinc current to all the provincial lines on which "time" is sent from the moment they are disconnected from their ordinary instruments until the positive or copper current which gives the actual time signal is sent; on the cessation of the time current, which lasts a second and a half, the zinc current again occupies the lines until they are once more joined to their instruments. The object of this negative current is to avoid the effects of stray currents from other wires, or "contacts" as they are termed, and other interruptions, by which a false signal might be given. It also serves to make the "time signal" more easily distinguished, as by this arrangement it is the reversal of a current, instead of a current sent into a line previously unoccupied.—No. 4. This is a still more powerful battery, employed to give the hourly time signals to the various local stations in London. The zinc pole is to earth, and the copper pole joined to the front stop of the local relay. In connection with this battery is a zinc and carbon battery, charged with sulphuric acid and water, which is joined to the other in the same fashion as the gas battery in No. 5, but with carbon to copper, and zinc to zinc. The power of the principal battery overcomes the force of the carbon and zinc battery, causing zinc to be returned on to the amalgamated zinc plate, and oxygen to be evolved at the surface of the carbon, and sulphate of mercury to be deposited on the surface of the mercury. At the moment of contact, the power which is thus gradually accumulated discharges itself almost with the force of a Grove's battery. This zinc, carbon, and acid battery, having a very small resistance compared to the constant Daniell battery, produces a current of very large volume, and requires no attention whatever.—No. 5. This is a powerful battery, similar to No. 4.; its zinc pole is joined to earth, and the copper to the front stop of the provincial relay. It is employed to send the positive "time signal" current to the provincial stations at 10 a.m., and to Newcastle at 10 a.m. and 1 p.m. Attached to this battery, as shown in the drawing, is a gas battery, consisting of a number of carbon plates arranged in a trough which is charged with dilute sulphuric acid and water. The carbon plates are carefully insulated from each other. The constant passage of the electric current through the gas battery decomposes the water, when hydrogen is thrown off on one side of the carbon plates and oxygen on the other. These gases are condensed in the pores of the carbon plates. When the time current is sent from the battery the accumulation of power is such, that a current is obtained almost equal to that from a Grove's battery.

(TO BE CONTINUED.)

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SOCIETY OF TELEGRAPH ENGINEERS.

At the meeting of this society, held in the theatre of the Institution of Civil Engineers, on Wednesday, Feb. 11, after the formal business, a paper, written by T. A. Makinnity, was read by the Secretary, on

Telegraphy in New Zealand.

It stated that the first attempt to introduce a system of telegraphy into New Zealand was made by the Government of Canterbury in the year 1862, the line first erected being from Christchurch to Lyttelton, a seaport distant eight miles. The next year the Government of Otago placed Invercargill and Bluff in telegraphic communication with each other. The next line was from Dunedin to Port Chalmers, a distance of seven miles, which was completed in the latter part of 1863. The work to connect Dunedin, province of Otago, and Christchurch, province of Canterbury, a distance of 255 miles, was commenced on the 4th October, 1864, and completed on 13th April, 1865. The line was carried on to Nelson, through the gold fields, and completed to that town in 1866.

The laying of the Cook Strait Cable, joining North and Middle Islands, was accomplished in August, 1866. After the laying of this cable communication was quickly established with Auckland, taking in the intermediate stations of Hull, Featherston, Greytown, Carterten, Masterten, Napier, Taupo, Tauranga, Grahamstown, &c., also with Taranki on the west. The line from Napier northwards was erected under great difficulties, owing to the hostile character of the natives of the district. The author then proceeded to give a graphic though condensed account of the natural features of the district, and suggested that it would be a good thing to embrace the first opportunity of visiting New Zealand, if only to view these wonderful works of nature.

On June 30th, 1866, there were 699 miles of line erected and 13 stations opened. Now there are in circuit 3,543 miles of line, carrying 8,444 miles of wire, exclusive of works in progress. These latter, when complete, will increase the line mileage to 3,621 miles, with 8,868 miles of wire. During the year ending 30th June last, 1,448,943 messages were transmitted, being an increase of 14 per cent. over the previous year, the cost being £96,801. There are 195 stations opened to the public, and the number of officials in the employ of the department is 801. The "collect" system is in use, but if the receiver refuses to pay, the sender is liable. The tariff is 1s. for ten words and 1d. per word after—address and signature not exceeding ten words free. The press rate is ten words 6d. and ½d. per word after, between 8 a.m. and 5 p.m. Evening papers are allowed 1,500 words during the day at the above rates. Delayed telegrams are received—that is, taken in at one time and transmitted any time during that day at the convenience of the department and posted at the destination the same night. Half-rates (plus 1d. for postage) are charged for "delayed" messages. Last year 56,721 of these messages were sent. Money orders can be sent by telegraph; the charge is 4d. in the pound commission in addition to the telegraph fee of 1s. The amount so transmitted last year was £61,693 9s., effected by 14,607 orders. Chambers of commerce are entitled to receive all shipping messages at the rate of 3d. per message, and the captains of vessels can telegraph to harbour masters at any port to which they may be bound to ascertain state of bar, wind or tide for 6d., which charge covers reply. The *employés* are mostly young men from the colony, trained by the department. The lines are of the most substantial character, No. 8 galvanised BBB wire, carried on poles varying from 20 to 30 feet, sawn from the heart of the Totara *(Podocarpus)*. Poles from 20 to 25 feet are 8 inches by 8 inches at the butt, tapering to 6 inches by 6 inches at the top. The battery in general use is the Daniell. To maintain this battery the cost is about 1s. 1½d. per cell per annum.

Fuller's bichromate battery has been introduced on some of the longer circuits, and has proved very efficient. The open circuit system is used, and every station is fitted with a battery cupboard, about 7 feet by 3 feet, with shelves containing the line and local batteries, the former consisting of 40 to 60 cells, the latter of 10 cells. The duplex upon Dr. Lemon's system is worked on No. 1 cable (42 miles), No. 4 cable (42 miles), Wellington to Napier (221 miles), Blenheim to Christ Church (206 miles), Blenheim to Dunedin (461 miles), Christ Church to Dunedin (255 miles), Dunedin to Invercargill (134 miles), Napier to Auckland (346 miles). Quadruplex working is to be introduced as soon as the instruments arrive. The Morse sounder is in general use. There are two cables connecting North and South islands—No. 1 with three conductors, No. 2 with one conductor.

First-class operators send and receive on an average from 1,000 to 1,500 words per hour, second-class about 750 to 1,000. The salary to cadets is £76 per annum, £80 in six months, £90 in twelve months, and £100 in two years.

Telephonic communication on private wires has, within the past year or two, come largely into use.

The New Zealand Station of the Eastern Extension Company is at Wakapuaka, a picturesque inlet from Blind Bay, about five miles north of Nelson. The staff of the cable authorities consists of a superintendent and three assistants, while that of the department consists of an officer in charge, and one first-class operator.

Mr. Preece read a note on the action of currents on telegraph wires. It has been asserted that electric currents cause iron and copper wires to become brittle. M. Gaston Planté has found that the powerful discharge from his rheostatic machine make fine wires very brittle, and the remark has been made that lightning rods are often found to become brittle. To test whether iron telegraph wires showed signs of brittleness from the passage of telegraph currents through them, Mr. Preece had a length of wire cut out of a line which had been erected near Bishopstoke, in Hampshire, but he could detect no signs of brittleness developed by the feeble currents used in telegraphy. The only wires which have been renewed in England have been those in the neighbourhood of smoky towns and manufacturers. In reply to Mr. Treunfeld, he stated that wires gave way in a few years near some towns. Mr. Stearns observed that brass and copper wires become brittle when simply left in store without the action of a current at all, and Mr. Stroh, while confirming this observation, added that the effect was especially produced in rooms where gas was burned. Mr. Preece also stated that several of his pictures hung by brass wire suddenly dropped, owing to the breaking of the wire.

Professor Hughes related that he had found both steel and iron wires to become quite "rotten" on being dipped into sulphuric acid, and restored to their former elasticity on being passed through a spirit lamp flame, as pointed out by Mr. Chandler Roberts, chemist to the Mint. This is probably due to absorption of hydrogen by the wire, and that gentlemen is undertaking experiments in the matter.

A paper by Mr. Eden was then read on the use of magneto-electric currents for telegraphy; the mode of application being novel. Mr. Preece drew attention to the fact that the Western Union Telegraph Company of America have superseded their cumbrous batteries by five Siemens' machines. The Post Office examined the plan seven or eight years ago, but found no economy.

A paper of Mr. C. Wilson was then read on induction in parallel circuits, in which the author repudiated the statement of Prof. Hughes that his plan would only answer for two lines. Prof. Hughes thought the number of condensers required, a grave objection to Mr. Wilson's plan.

PHYSICAL SOCIETY.

The annual *conversazione* of this Society was held on the evening of Saturday, Feb. 7, in King's College. The Museum of King George III., the Wheatstone Laboratory, and other halls of the College were occupied by a fine display of physical apparatus and artistic furniture, including numerous relics of Sir Charles Wheatstone. There was a large number of ladies and gentlemen present, and during the evening selections of music were played by the Musical Association of the Royal School of Mines. The apparatus was peculiar to the whole range of physical science, and was furnished in part by the College and in part by the various instrument makers and electric engineers of the metropolis. The Telephone Company and the British Electric Light Company contributed telephones and electric lamps, and Herr Faber exhibited his ingenious speaking machine. Among the various objects on view, we may mention the original Wheatstone Bridge, various forms of polar clock, the medals and orders conferred on Sir Charles Wheatstone, the De Kempeln speaking machine, made by the latter, and the drawings made by him in 1848 to illustrate his scheme for laying a cable between England and France in 1848. The president of the Society, Prof. W. S. Adams, exhibited a selenium photometer, in which the light, falling on a selenium rod, deflects the light-spot of a reflecting galvanometer. Mr Stroh and Mr. Tisley showed their harmonographs and other sound delineators; Mr. Willoughby Smith exhibited specimens of the earlier cables, Mr. Latimer Clark a portion of the Ronald's 1816 telegraph line and the original Cooke and Wheatstone 1837 instruments, together with some of the original type for the 1832 Morse telegraph. Messrs. Elliott Brothers, Mr. Browning, and Mr. Sabine also contributed specimens, and there was a beautiful Hughes induction balance, made by Mr. W. Grove.

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THE ELECTRICIAN.

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MAGNETIC "CURATIVE" APPLIANCES.

Can anybody inform us what a "magnetic current" is, or give us any verifiable evidence that it can do work, or produce any physiological effect? We are particularly anxious to obtain information on these points, because both of the letters which, in our issue of the 24th ult., conclude the brief correspondence on *Magnetic Appliances* contain this expression; Mr. J. Wilkinson informing us that "the magnetic current is continuous and most penetrating," and Mr. Harry Lobb—whose name is well known in connection with the medical applications of electricity—stating that "magnetic appliances when worn upon the body produce magnetic currents, which we all know (?) closely resemble, and are intimately allied to, electric currents." Moreover, since the date of this correspondence, we have made the acquaintance, through one of its numbers, of what we presume is a contemporary, bearing the title of *The Magnetic Review;* and we have received some half-dozen trade pamphlets, all of which enlarge, in glowing terms, upon the multifarious curative virtues of the "magnetic currents" generated by appliances which, no doubt, may be shown to be more or less magnetic, but in which we should say that the really active agent is decidedly flannel. Our contemporary in question devotes about half his space to advertisements and testimonials relating to one of these appliances, whilst of the other half we can only say that it is devoted to the literary and scientific requirements of probable customers. In the latter portion, an "editorial" informs us that "what is called the luminiferous ether is but another name (*sic*) for Magnetism," that "the currents from the two poles of a horse-shoe magnet rush together" and "constitute a permanent magnetic atmosphere, corresponding in strength to the dimensions of the surfaces from which they emanate" and that "the enormous magnetic force at the poles . . . has contracted the solid earth until our polar diameter is twenty-six miles less than at the equator." But the interest of the paper is not confined to the "leaders." In a communicated article we are told that "in cases of fever the electric equilibrium is always destroyed; there is an excess of positive electricity; the skin is hot, the throat is parched, and the expanded brain refuses to sleep; the instinctive cry is for water; and how grateful is cool water applied to the skin. The electricity of cool water is negative, so that thirst in fever should be fully gratified, and perspiration promoted on the skin, so that the excess of positive electricity may be carried off, and electric equilibrium restored. Cold water in fever conveys a soothing magnetism throughout the whole frame." Nor is the writer in this case satisfied with the mere statement of such important scientific facts; he proceeds to show how the "negative electricity" and "soothing magnetism" of *cold* water may be utilised on a large scale. "An excited mob suffers from an excess of positive electricity and morbid heat. Under great excitement they become maniacs in their frenzy. The most instantaneous and effective remedy is a complete saturation with cold water; its negative properties draw away their positive electricity, cool the fever in their blood, and howling infuriated madmen are converted into rational beings. A few hose pipes attached to vigorous fire-engines would be infinitely more effectual in restoring a mob to reason than snider rifles." And to those whose offspring may suffer from "excess of positive electricity," and may require a "soothing magnetism," the valuable hint is given that "the same rule applies to irritable children; a bath tub is more rational treatment than the birch."

In another part of the same article, we specially note that "all nature is magnetic; every drop of water that comes to us in rain-falls is a perfect magnet." We were under the impression that some bodies in nature, including that of the writer of the article, and particularly the fluid *water*, are diamagnetic, and cannot be made to assume magnetic polarity. But then Faraday was not infallible; and, if there be a little hitch here, it is soon forgotten when we read how beautifully magnetism acts as "the soother and harmoniser of Nature's disturbances." We will conclude our extracts from this article with one more bit of information, explanatory of the effect of *cold* water. "Heat is indispensable to life; but an excess of heat indicates an excess of positive electricity. An excess of cold indicates the opposite or negative condition."

Turning now to the advertisement department, we find, amongst the "special advantages" of the particular appliances therein recommended "their constant generating of electricity without the aid of batteries, metallic plates, chain-bands, or acids." This, too, in addition to a *magnetic current* which "passes readily through an intervening garment!" Can those of our readers who are striving to reduce the inevitable loss which occurs in the conversion of mechanical into electrical energy realise, by an effort, the full value of this wonderful but simple invention? Why, it is nothing less than perpetual motion—the overthrow of the

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principle of the conservation of energy! Do you refuse to admit this? do you assert that the electrical effect on the body, if produced, must be attended with an equivalent diminution in the motion of the *blood?* You are wrong. In the first place the lines of fluid particles do not ordinarily move in a direction perpendicular to their length, so as to cut the lines of magnetic force; and in the second place we find, in another of the advertisements in our contemporary, that "by the wearing of magnetic appliances, additional magnetic currents are soothingly [how enticing are this adverb and the corresponding adjective!] infused into the system, thus giving *a better circulation*, [the italics are ours] together with greater purity of the blood and increased nervous action. Are you not now convinced that we have here a case of perpetual motion?

Taking up one of the pamphlets above referred to, we are assured that "When it is fully known that magnetic currents are as healthful as pure air, and as indispensable to the life of man; that they are not confined or local forces, but form a general principle, pervading all material things; when it is understood that man himself is truly magnetic, [how *could* Faraday make him diamagnetic?] *then* the employment of this powerful agent in the cure of disease will become general." Surely, in presence of evidence such as that laid before us, the period anticipated cannot be very long in arriving. In this *brochure*, and in one or two of the others, we find the statement, put forward on the authority of a Dr. James Chapman, that "During the last visitation of cholera it was noticed that telegraph clerks and those who were continually brought within the sphere of *magnetic* influence were exempt from choleraic attacks—the close proximity of the magnetic element doubtless neutralising the subtle effects of the earth's disturbed magnetism." Some of our telegraphic readers will rejoice, no doubt, at being favoured by circumstances with such immunity; whilst few, we think, will have the perversity to omit to magnetise their pocket-knives and brace-buckles, since magnetism in homeopathic doses is evidently productive of the most beneficial effects. In another pamphlet, the writer asserts, as a fact within his own knowledge, that "the 'magnetic currents' can be controlled, varied, reversed, or removed at the pleasure of the wearer," and that "invalids can localise a 'magnetic current,' or make a complete circuit at will." Unfortunately, our own appreciation of these important statements is marred by the fact that we do not know what a magnetic current is. With the magneto-static circuit, and with some of its laws, we are tolerably familiar; but as to the magneto-dynamic circuit we have to confess our total ignorance. Will none of our readers enlighten us?

It is remarkable that, from the evidence before us, magnetism would appear to be much more efficacious in homeopathic than in allopathic doses. From powerful steel magnets carried about on the person, and from still more powerful electro-magnets kept in proximity to the body for several hours, we have never been able to observe the slightest effect. Our experience is that even those persons who are termed "magnetic sensitives" are totally unable to perceive, through any physiological effect, when the circuit of a strong electro-magnet is completed and when it is broken. That this is the case was fully shown in some experiments with two renowned "sensitives"—Miss Tilley and Miss Mansell—which were carried out in our presence some years ago. The following statement by Dr. Pereira, referring to some experiments by Faraday, is of interest in this connection:—

"As all substances are under the influence of the magnetic force, it might be expected that the vital functions would suffer some modification from the action of magnetism on organised bodies; but hitherto no conclusive and unequivocal evidence on this point has been obtained. Various phenomena have been ascribed to it, but the inconstancy of their occurrence throws great doubt over the opinion that they are really the effects of the magnetic force. The failure of their production in persons on whose statements confidence can be placed, and their occurrence chiefly in females, and in those called nervous, are reasons for suspecting some error or fallacy in the statements of practitioners who advocate the influence of magnetism on the vital functions. Dr. Faraday does not appear to be susceptible of the magnetic force; for some years ago he allowed Dr. Keil to try, in a variety of ways, the influence of powerful magnets on him, but no perceptible effects were produced (*Lancet* for 1835-36, vol. 1, p. 716), and he informs me that he was never sensible of any effect produced on him by the powerful magnets which he used in his recent experimental investigations on magnetism (see *Phil. Trans.* for 1846), although he purposely submitted various parts of his body to their influence, and tried in all imaginable ways to obtain some evidence of their effect."

Dr. Pereira nevertheless describes some modes of using magnets for curative purposes. "For toothache," he says, "a *simple straight* or *bar magnet*, sometimes called a *magnetic staff*, is used. It is first made warm, and its *north* pole applied to the tooth; if the pain be not relieved, the *south* pole should then be substituted." Unfortunately, Dr. Pereira does not tell us what is to be done if the south pole is equally ineffective, an omission which has been fatal to success whenever the process has been tried in our presence.

We wish clearly to define our position in relation to magnetic curative appliances in general, and such things as *Skeuasma*, *Amynterion*, *Magneticon*, *Magnetine*, and magnetic *lung* or *nerve Invigorators* in particular. We have no intention or occasion to occupy illogical and dangerous ground by stating an absolute negative. We do not assert that under no circumstances can magnetism have any effect upon the complicated and delicate functions of the animal organism; but we do say that it has not been shown either that it performs any physical work or exerts any physiological effect whatever, even under conditions in which the magnetic force is intensified almost to the highest degree practicable. In regard to any alleged psychological effect, we can only say that it is altogether outside our province, and that, to be admitted, it must be susceptible of experimental verification. In regard to that portion of the question which is more particularly within our province, we are bound to go even beyond the position we have above taken up. A magnet is a mass, most frequently of steel, in which is stored up a certain quantity of magnetic energy, viz., just sufficient to do the work of completing its own circuit, since when a perfect magnetic circuit is formed all magnetic energy disappears. It is therefore impossible that a magnet can do any physical work unless (*a*) the mass undergoes a chemical or molecular change, (*b*) the magnetic energy varies, or (*c*) energy is supplied from without. Lastly, in regard to any physiological effect, it is not even claimed that the most powerful magnet can affect the irritability of nerve, the contractility of muscle, or the circulation of the blood as shown in the frog's foot under the microscope. Under these circumstances, an expression of the opinion that the various "magnetic" appliances are absolutely without any curative efficacy cannot be correctly termed "dogmatic." We are aware that the popular belief and the consequent trade in such appliances are assuming very extended dimensions, and that testimonials *ad libitum* are

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forthcoming. These testimonials in fact constitute the only positive evidence put forward as to the presumed efficacy of the appliances in question. Knowing, as we do, something of the history of "galvanic rings," and of other specious quasi-voltaic delusions, several of which are even now extensively prevalent, we attach very little importance to these documents. The fallacy of such testimonials is due mainly to a very simple and innocent cause—a confusion between *post hoc* and *propter hoc* on the part of the writers. As an "electric star" would be fully as efficacious with a pellet of paper enclosed within it as it is with fragments of copper and zinc threaded on to a copper wire and similarly located, so, in our candid opinion, the various "magnetic" curatives would bring in the same number of testimonials if they were issued with strips of whalebone inserted in lieu of the wonderful magnets. We doubt not that there are many honest advocates of, as well as believers in, curative magnetism; but a large proportion of what is put forward in relation to this subject strikes us very forcibly as being that particular combination of ignorance and impudence which, in conjunction with rapacity, constitutes the worst form of quackery.

CORRESPONDENCE.

THE SCHOOL OF TELEGRAPHY AT THE EASTERN TELEGRAPH COMPANY'S STATION, PORTHCURNOW, PENZANCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It may be of interest, and a sufficient reply to the article from Zante, published in your issue of last week, to show what companies are doing to promote the efficiency claimed in that article for foreign Governments.

The above Company's station in England, in addition to being the transmitting office between their land lines to London and the cables to Spain, Portugal, the East, Brazil, &c., is utilised as a training school for their future clerks, as it is found better to train clerks from the beginning to the system they will be required to work when they arrive at the different stations.

Porthcurnow, the name of the cove where the cables are landed, is about nine miles from Penzance and three from Land's End, and here, away from all town life and its attractions, free to roam about over the cliffs and lanes when not at their duty, these young probationers spend the first ten or twelve months of their early experience in telegraphy.

It is preferable for intending telegraphists to commence their profession when young, say between the ages of fifteen and seventeen, as it is found that the fingers are more readily adapted to the peculiar position of holding the keys and the capacity more easily comprehends the different signs and signals which form the telegraphic alphabet. It may be also that there is something incongruous to a mind maturely developed to be set about learning a new A B C; at any rate it is an established fact that the smartest telegraphists are those who commence when young.

The first thing to learn is the different combinations of dots and dashes which make up the Morse alphabet, as published in the Convention, including diphthongs and accented letters, for, although, in English words, these signals are rarely used, when working with foreign administrations they form part of the general alphabet.

After a few days, the signs being now quite familiar, an old "slip," containing proper messages, is supplied for the probationer to transcribe and write off on paper. As there are many details in a day's working which are not understood by a novice, the first attempts are generally a jumble of words and signals; but these very peculiarities, being explained, serve to give instruction as to the actual mode of working, and, after a little practice, messages are easily read from the slip. These are examined by the instructor, but not compared with the slip for errors, many of which are detected by merely reading over, as accuracy at this early stage cannot be expected. After a fortnight's practice, or as soon as fair progress has been made with the Morse signals, the Recorder alphabet is learnt, and slips translated in the same way. It may be mentioned that although the Recorder alphabet is looked on as more difficult than the Morse when first commenced, after both are properly learnt the Recorder signals are preferred.

During this time, although the probationer has not been given the duty or instruction in the manipulation of the sending keys, if he is intelligent and interested in his work, it is found that he has acquired some knowledge of sending, so that with a little instruction and supervision he is able to send as well as receive the signals.

The Mirror is the next instrument that he is taught to read from. It is more difficult, and, being less used, the present junior clerks do not excel in it. With the Recorder working well and regularly day after day, there is no necessity to revert to Mirror, so that good Mirror clerks are becoming "few and far between;" but if the necessity did arise it would only require practice for the present clerks to become good Mirror clerks, the basis having been obtained.

There are two practice rooms fitted with instruments and wires leading from one to the other; the learners are placed at each end of the line, the instructor in one room, and after a little instruction they commence slowly with messages composed of newspaper cuttings. When possible, a more advanced probationer is placed with a beginner. This is an advantage to the latter, and gives the former a good lesson in patience. After some time old messages with code words are substituted. The plan of working is for one to read two hours, then change with the writer, and the next day the sender to change with one of the readers. This practice continues alternately, "practice Morse," (at practice Morse two and not three work together), "practice Mirror," and "Slips;" occasionally a week at entering the day's proper messages into the abstract book. When the probationer is able to read and write off messages at a good speed, he is sent into the instrument room to write off the messages as received behind the proper clerk. These are compared with the messages, and all errors here, as with the practice work, are recorded, and either carelessness or errors are now severely censured. It is in the instrument room that an opinion is formed of a probationer's future value. If he is quick and accurate he is also eager to do the work whilst the clerk checks after him instead of the learner checking after the clerk, and so he gradually becomes competent to take charge of the circuit. Precaution is, however, necessary, and the clerk in charge of the circuit is responsible for the work done.

Once a week there is a dictation lesson; all mis-spelt words have to be re-written six times out of office hours, and if the writing is careless the whole must be re-written two or more times. This is also done sometimes with the practice work. Accurate spelling and writing are of as much importance as manipulation. Indistinct writing is mis-read by the clerk who transmits the message, and errors occur which cause fresh messages to be sent. In these days of competition, a client who telegraphs frequently may, if errors are made in his message, "go over to the enemy," and his valuable custom be lost.

As our object is to produce good manipulators, we have devoted more space to this particular subject, but another object is to make our present clerks more intelligent and less dependent when any extra difficulties arise.

There are three classes for electricity. The first, elementary, treating of frictional and voltaic electricity, magnetism and electro-magnetism, the chemical action of the different batteries, and ordinary connections of instruments. In the next, the principles of electricity, Ohm's law, resistance, potential, &c., telegraph instruments, Morse, relays, cable relays, with the moving zero contact, Thomson's Recorder, duplex land lines and cables. In connections, circuits with faulty wires are inserted, and a proper system of testing for these faults, so that everything is explained which tends to make a clerk conversant with the details of his instrument, in order to save time when any irregularity does occur. The advanced class is taught general testing, battery resistance, insulation, copper resistance, &c. Artificial faults are made and practised on, but it is only when a probationer is here longer than usual, or shows remarkable aptitude as an electrician, that he takes part in testing.

After the lectures, questions are given which are answered during the week from notes taken at the lecture and books in the library. The answers must not, however, be copied from books, but be given in the student's own words.

Each probationer takes his turn four hours a day for a week in the battery room, making up, refreshing, and testing the batteries in use, thus obtaining the details of battery working, and it is found that this practical experience often leads to questions and investigations which mere theory learning would not suggest.

The land line between this and Penzance is maintained by the company, and when the lineman goes out repairing, renewing, painting poles, or cleaning insulators, a probationer goes with

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him, so as to get instruction in line work, which he will probably find useful at some of the stations.

Those who have a mechanical turn are allowed in the workshop to get instruction as to the cleaning of instruments, winding wire, soldering, turning, &c. All receive lessons in cable jointing, commencing with soldering the conductor, and finishing with the outer covering.

In order to encourage their electrical knowledge, two probationers may fix a circuit between their bedrooms on condition that everything is done by themselves.

A monthly examination is held in every subject, Mirror, Morse and Recorder reading, sending writing, and electrical knowledge. According to their average position in these subjects their grade on the staff list is fixed. A copy of this is posted in the office, and one sent for the managing director's inspection. The clerks are divided into three classes; those in the first are available to be placed on pay or sent abroad, the second take duty in the instrument room, and the third in the practice room. If a probationer does not sufficiently improve to be advanced another grade, after six months his services are dispensed with.

It is not to be supposed that a probationer becomes proficient in twelve or eighteen months, but if he has ordinary ability, and likes his duties, he becomes very useful by this time, so that he looks forward after about nine months' probation to receive an appointment at home or abroad.

The greatest excitement prevails as to who will be the fortunate ones selected when it is known that clerks are required abroad. No one wishes to remain here. The love of travelling, the desire to see the world, and the prospect of gaining an independent livelihood, all tend to make them push on and become competent, and if they do not do this the sooner they seek some more congenial employment the better for all.

It is unquestionably better, as your correspondent from Zante insists, that telegraph operators should know one or more languages besides their own. In many cases amongst those joining the Eastern Company's service the elements of French and German have been acquired, and as many of them are sent to such stations as Marseilles, Bonn, Lisbon, Vigo, and the Levant, there are now a large proportion in the service who are familiar with several European languages. All probationers seeking to enter the service should acquire as much knowledge as possible of algebra, logarithms, and decimal arithmetic, as they cannot hope to go far in the knowledge of electric science without some proficiency in these branches.

The desire of the company is that Porthcurnow as a training school should be as much like foreign stations as possible, so that intelligent recreation, lectures, private theatricals, and church attendance are encouraged and duly reported to headquarters; and where a probationer shows no aptitude, has no heart for the business, or has acquired habits likely to do himself or others harm at isolated stations, he is advised to resign. I think this article will show the foreign correspondent that telegraph companies are as much alive to the necessity of educating and thoroughly training efficient operators as any Government department can be. It is seven years since a systematic training was established here, and every plan thought of for making high class operators, but we do not agree with your correspondent that the old simple instruments are sufficient. There is great room for excellence, and I am glad to say great progress made in every branch. Batteries, Morse keys, Recorder, and Duplex apparatus have all been improved, and probationers are taught to care for every one of these, so as to keep them in the most complete working condition. We think that very little is left undone, and that the acknowledged rapidity and general accuracy with which telegrams are transmitted over the world fully proves that telegraph companies are in no way behind Government departments.

W. H. A.

THE ESSENTIAL NATURE OF ELECTRICITY.

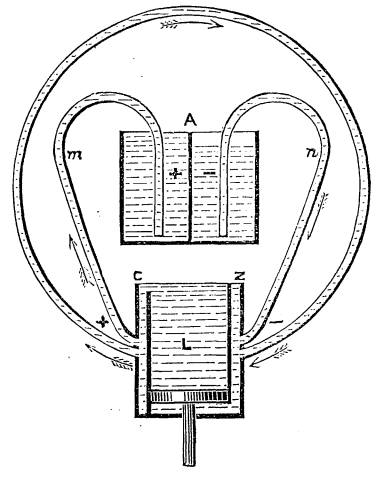
TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your readers and Mr. Sprague will, I am sure, excuse me, under present circumstances, for not replying to that gentleman's letter at any great length. *Ubique ducit veritas* is evidently his maxim as well as mine; and I have very little doubt but that, after some further study, we shall arrive at a tolerably close agreement. The question as to whether that which we call *electricity*, and express in symbols by

$$Q = I\,t = \frac{E}{R}\,t = \frac{E\,d^2\,t}{l},$$

may not be merely a supposititious cause for effects which we observe to vary in a ratio different to that in which electrical force ($f = E^2$) or electrical energy $\left(\frac{E^2\,d^2\,t}{l}\right)$ are known to vary, is a perfectly legitimate one for discussion, and should be fully discussed. In this, I think, it differs *toto cœlo* from the questions whether Electricity is a *force*, a *form of energy* or a *mode of motion;* for it seems to me obvious, even in the light of what is now generally understood, that, if there be any *thing* corresponding to $\frac{E}{R}$, this entity may be associated with varying quantities of force and energy; and in my humble opinion, therefore, an affirmative conclusion in regard to these questions can arise only from want of experimental knowledge, misconception or erroneous application of mechanical terminology.

I would observe in the first place that it seems hardly possible to treat the question fairly without taking it into the domain of electrostatics, either before or after considering it from the point of view of the conductive circuit. In the words of the first Napoleon, it may be said of an electrician who would consider this question *qu'il doit être carré*, he should not limit himself within one branch of his science. In the second place, I would suggest to Mr. Sprague that, in the hydraulic illustration given by him in his book and referred to in his letter, the analogy with the voltaic circuit, though of course far from perfect, is yet more perfect than he has supposed. He finds it to fail when he considers the electrostatic circuit which is an invariable concomitant of the electrodynamic circuit. I think the analogy may be extended so as to apply in some measure to the conditions in the former circuit. In the figure, let L represent Mr. Sprague's



pump; the piston of which, being pushed upwards, disturbs the equilibrium of fluid pressure, as an electromotive force disturbs the electrical equilibrium. In addition to the pipe which conveys the water in a circuit, let there be two pipes, *m* and *n*, which connect the outlet and the inlet respectively with the two compartments of a vessel A, divided by an impervious partition. If the resistance opposed to the passage of the current be sufficient, there will be an appreciable difference of pressure in the compartments, analogous to the difference of tension in a charged condenser. I need not point out that, by means of a more elaborate diagram, the conditions in the actual circuit could be more closely illustrated.

Lastly, I have to point out that, although Mr. Sprague is practically correct in maintaining that, in a given voltaic circuit, the energy expended, or the work done, must vary as the square of the molecular motion or velocity, whilst quantity or current varies simply as the velocity, this statement requires qualification, since it is accurate only when *force* varies as velocity. A few equations will, I think, make this quite clear.

Since in all cases of uniform motion, work is expressed by $f\,s = f\,v\,t$, and in all cases of uniform current by $\frac{E^2}{R}\,t$, we have, in unit time and with a given mass,

$$\frac{E^2\,d^2}{l} \propto f\,v;$$

therefore

$$E^2 \propto \frac{f\,v\,l}{d^2},$$

$$E \propto \frac{\sqrt{f\,v\,l}}{d},$$

and

$$I = Q = \frac{E}{R} \propto \frac{E\,d^2}{l} = \frac{\sqrt{f\,v\,l}\,d}{l} = \frac{\sqrt{f\,v}\,d}{\sqrt{l}}.$$

Since mass may be expressed as $m = d^2\,l$, we have

$$I \propto \sqrt{f\,v} \times \frac{\sqrt{m}}{l}$$

In the first equation, a double force, producing a double velo-

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city, gives a fourfold quantity of work; in the last, a double force producing a double velocity gives only a double current. I think I am quite in harmony with my friend in considering it to be almost certain that the *modus agendi* of electrical conduction is a rotation of molecules.

The question—from the point of view selected by your correspondent—is whether the value in the last equation can be taken by the physicist in substitution for the idea of electricity as an actual entity? My own view is that it cannot.—Yours, &c.,

DESMOND G. FITZGERALD.

ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED).

The ordinary general half-yearly meeting of the above Company was held at the City Terminus Hotel on the 6th inst., under the presidency of Viscount Monck, the chairman.

The SECRETARY (Mr. John Grant) read the advertisement convening the meeting, and the minutes of the last ordinary general meeting, which were confirmed by the present meeting, and signed as correct by the chairman.

The report of the directors, the salient features of which appeared in *The Electrician* of last week, was taken as read.

The CHAIRMAN, in moving the adoption of the report and accounts, and the payment of the dividend in accordance therewith, said: The natural division of the subjects which he had to bring before them coincided with that which prevailed in a larger and more important annual meeting in which he took some concern on the previous day—namely, to divide itself into their domestic and foreign relations. With regard to their home work, the report, he thought, had made it pretty plain that he had nothing to tell them that was not eminently satisfactory. Their property was in good condition, and their cables were working with their usual efficiency; while their income had, as they would observe, very largely increased within the last half year as compared either with the preceding half year or the corresponding six months of 1878. They proposed, as they stated at the last half-yearly meeting, to lay down a new cable this year between Ireland and America, and they had the pleasure to tell the proprietors that they were in a position to do that without asking them or the public for one shilling of the money. They proposed in addition to that to lay down or renew, as they would observe by the report, other portions of their system, which had either worn out or become inefficient—he referred to the short cables connecting the island of Newfoundland with the continental portion of America, and that was a work which was absolutely necessary to be done in order to the efficiency of their system. They proposed to do that also out of money in hand. There was some doubt expressed at their last meeting, he thought, about the propriety of laying down a new cable between Ireland and America this year. The argument used, as he recollected it, was that when a cable got to the bottom of the sea it more or less deteriorated in quality, and, therefore, the longer, consistently with the efficient performance of their work, they could put off laying down a new cable the better. Well, no one was more ready than he to admit the general soundness of that argument; but it must be taken with certain qualifications. In the first instance, the enormous increase in their traffic had rendered it absolutely necessary that they should keep at least three cables in full work. Their three cables were working, each performing its full share of the work; but they must remember that one of those cables was very nearly eleven years old, and, without any disparagement to its condition, they must be prepared for contingencies—he would go no further than that. There was another view of the matter. He had not yet alluded—and his allusion would be very short—to their foreign relations, and by that he meant to express what they were all aware of, the cable which had been laid down by the new French company. The result of that would be a competition, and competition, as he understood, and as they had already announced, could only be carried on by a very considerable reduction of tariff, and a very considerable reduction of tariff meant nothing more than a very considerble increase of traffic; and in order to carry that increase of traffic with a reduced tariff as efficiently as they had done hitherto, they must be prepared with additional instruments for the working of that traffic. There was another view of the matter. They were not fools; they did not mean to go on competing and fighting for ever. Sooner or later they must come to an arrangement, and their share of profit arising out of that arrangement would depend very materially on the number of efficient cables they would have when it was made. He thought he need not trouble them further on that point, because he was satisfied, from the tokens of assent from all parts of the room, that the proprietors were convinced that the Board ought at once to exercise the powers they had of laying down the new cable. They had made arrangements, or arrangements were in progress, for a new survey of the bed of the Atlantic, so as to obtain, if possible, a better resting place for their new cable than had been afforded to those which had preceded it. It had been suggested that they should make experiments as to the coating of their cables. Well, that was a matter on which they had been engaged, and they were in great hopes, from the turn things had taken, and the result of the experiments made, that they would be able to get a class of cable which would more effectually resist the deterioration of whatever influences might be brought to bear on it under the water than any yet which had been laid down. He might say at once with respect to this new cable that they were doing everything they could to secure an intrinsic superiority in the cable itself, and the best possible bed for it in the bottom of the Atlantic. He did not know that there was anything else connected with their home relations to which he need refer, but he might anticipate some objections which might be made with respect to the expenditure of the last half year. They would see by abstract A—expenses at the head office in London—that there was a considerable reduction, a reduction of £850 odd in expenses at the head office during the last year. There was a considerable increase in the expenses at the out stations, but he thought if any gentleman would take the trouble of running his eye down that column and see the points in which the principal increase had taken place, he would at once recognise that it was attributable to the enormously increased traffic, and that it was only a very small per centage they paid for their increased gains. They could not do double the work without getting double assistance for it; and if they had double assistance they must pay for it. That was really the whole explanation. There were certain large items. For instance, there was the item of maintenance of land lines, instruments, and instrument stores, which they could not avoid—things would wear out and they must replace them. Then, repairs and furniture—that came under the same denomination. They had also been obliged to put up additional buildings at Valencia for their increased staff there, and in order to replace the building worn out. There was also an increase in the expenses for use of patents. They had duplexed all their Irish and Newfoundland cables, which were working most admirably, but for which they must pay. So far for their home work. He had alluded, incidentally, to the French company. The French company had laid down their cable to America, and they had been expecting that the competition would begin, but up to that time the French company had not interfered with them in the slightest degree, though they had announced that they were open. They were told a year or a year and a half ago, when that operation was first started, that one of the first motives of those patriotic individuals who set it to work was to gratify the *amour propre* of the French people, and it appeared that that was not only incidentally their object, for it appeared to be their only object. It appeared that they were quite satisfied to have laid the cable without working it. How long that was to continue they did not know, but he did not care how long it lasted, having regard to the proprietors' interests, for every day the French company acted on that principle of self-abnegation was worth thousands to this Company. At the same time, if they offered this Company terms which they considered reasonable, they were not averse to work at amity with them. His belief was that there was room for them all. With those observations he would ask them to place the same confidence in their directors which the latter had so often experienced at their hands, and to leave the negotiations with them to deal with as they thought best. He considered that the state of their affairs proved that the directors were entitled to their confidence. He thought that the gloomy anticipations which for several years past had been made with regard to the future of the Company had not—at all events up to the present—been realised; and his thorough conviction was that as they had gone on for the last ten years, so they would go on in the future, managing their affairs with prudence and determination, realising for them a fair revenue on their outlay, and maintaining their property in good and serviceable condition.

Sir DANIEL GOOCH, Bart., M.P., one of the directors, seconded the motion.

Mr. GREENWOOD wished to ask a question, but not to oppose the motion in any way. He observed, however, in the report the following paragraph:—"The directors, under the powers conferred upon them by the articles of association, have, before declaring the net profits, set apart the sum of £140,000 to the renewal fund." That was a very enormous amount, representing, if set aside every half year, £280,000 a year. He was not, however, finding fault with the amount. He thought in present circumstances that it was most judicious to set aside a large amount; but he wished to know what were the exact powers of the directors in the matter. What was the limit? Or could the directors go on putting such an amount aside for as long as they thought proper?

Mr. JACKSON wished to ask a question as to the paragraph in the report which referred to the abandonment of two of the cables. He desired to know the cost of replacing them, as he thought it would be satisfactory to the shareholders to know. He thought, with regard to the report itself, that the impression on the shareholders must be twofold; first, that of serious depression that two more cables—though, it was true, they were not deep-sea cables—were actually abandoned by the Company. That, however, was a perfect evidence of the judiciousness and the necessity of the directors in providing such a large reserve fund for these matters, but he thought the fact of such abandonment was a subject for regret. A matter of unmixed satisfaction was that their receipts for 1879 had exceeded those of 1878 by £116,000, though they were not permitted to divide it. There was one satisfactory feature in connection with what the chairman had said as to the French company and dividing the profits on the basis of the number of cables on the ground. It should, however, be remembered that the new company, with its new cable, had to work its way, as this Company had done, through trials and difficulties, before it realised a moderate result; but even supposing, in any arrangement being come to, it did get its proportion of the profits, it would receive only one-sixth, which would come within the amount of the increased profit this Company had made in the past year. He mentioned that because he thought it might be satisfactory to those shareholders who might not have gone into the figures to know that even if they were deprived of one-sixth they would still have what would give them their present dividend, which he thought was very satisfactory, particularly to those who had bought their shares at present prices. He was very gratified to hear the chairman's remarks as to the experiments which had been made for securing an improved outer covering for their cables, and to believe, as he gathered from those remarks, that they had accomplished satisfactory results as to sheathing the cable with such a substance as would make it more durable. If they could see a fair chance of looking to fifteen or twenty years as the "life" of a cable, a quarter, or half, at the most, of their present reserves would suffice for the purpose. He knew that their manager liked to be "square," and give the shareholders plain facts and the plain truth, but he hoped that gentleman might be able to confirm the aspirations which he (the speaker) had expressed.

Mr. SEELEY asked the reason of the Board for abandoning the daily publication of the returns of the traffic. He was very much surprised to hear that the French company had not commenced to work. He thought that they had, and that they were in competition. He also asked a question with regard to the item in the renewal fund of "cash not yet invested," £115,000, and the item on the credit side of the balance-sheet of deposit and ordinary cash balances, £46,000.

Mr. J. NEWTON said he was surprised and disappointed to hear the chairman say that they had entered into negotiations with the new French company. From the number of meetings he had attended of this Company, he thought they had determined to fight for the monopolies which were granted to this Company when it first started—monopolies which he believed no company that was ever formed in the world more righteously deserved.

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This Company, at its own expense, proved to the world that it was possible to lay a submarine cable in deep water. For that great work they obtained the monopoly and privilege of having the traffic throughout all England, most of the traffic of North Germany, the traffic of all France, and practically, the command of the traffic for the whole of Europe, for the great work the Company had done. He thought that, with the strong position they occupied, negotiations should not have been entered into with the new French company so early. It appeared that they had been over here, and had had negotiations with the Board, and the result had been known, or presumed to be known, on the Stock Exchange, and the shares had been going up and down as a consequence.

The CHAIRMAN: Up, not down.

Mr. NEWTON thought, seeing that this cable was not required, that it was not a cable called into existence by money provided by shareholders, but the result of the jobbing work of a set of cable manufacturers, who were the enemies of all those who had invested money in these companies, that what the chairman had said was matter for surprise. There had been something like £20,000,000 laid out for the purpose of providing the world and civilisation with this great work, and because it had been done so well, and it was just possible that some other company might like to get some of the plums of the work, these jobbers made cables before they were wanted, and then came to companies like this and wished to negotiate. He was perfectly surprised to hear that a compromise would be based on the number of effective cables they possessed. He remembered the competition threatened on a former occasion; but after the amalgamation of this Company with the French Atlantic Company, and in view of it he sent a proposition to the directors, indirectly suggesting that instead of the scheme of preferred and deferred stocks they should, under the amalgamation, adopt the system of preferred and deferred messages, the Anglo carrying the deferred, and the original French Atlantic Company the preferred messages, the former to be carried at rates which would command nearly all the traffic from Europe to America, and the preferred messages, the most important ones, to be charged a higher tariff. He believed it was said at the time that that could not be done legally, owing to the amalgamation; but it might be done now, the Anglo taking the deferred and the Direct the preferred messages. He thought, with the strong position now occupied by the Anglo Company, that by going down to sixpence or threepence a word they could take every message sent from Europe to America, unless specially directed to go by the new competing French company. This Company must have the messages—there was no power to prevent it if they had the same rates as the French company. They would then be able to dictate terms to the new competing jobbing cable. With this Company's monopolies they could put that company in such a position that their recepts would bring them to an arrangement on a much lower level than on the basis of having one cable against five; they were, therefore, entitled to one-sixth of the total receipts. He maintained that if they would fight the French company for a little longer they would buy them up on the same terms as they did, practically, on a former occasion, when they took over another jobbing company. He thought the Board appeared somewhat as if they had been caving in.

The CHAIRMAN said he would try and answer as well as he could the several questions put to him. Mr. Greenwood had asked what were the powers of the directors to add to the renewal fund. The powers were unlimited by the articles of association, but he might at once explain that they had no intention of maintaining the contribution to the renewal fund to the same extent as they had done this half year. It was a purely exceptional case. They had had very large receipts, and they would have very large outgoings this or next year, and they had laid aside this extraordinary sum, about £65,000 more than they would have done otherwise, to enable them, as he stated before, to do all the permanent work they would be called on to do this year without calling on the proprietors for any further capital. Mr. Jackson had asked a question as to the inter-island cables. Those were very old cables; they were not laid by this Company, but by the Newfoundland company, and Mr. Jackson, who was perfectly conversant with all the changes that had taken place, would recognise how old they must be. They were ten or twelve years old, and they must be renewed.

Mr. JACKSON said he had asked as to their cost.

The CHAIRMAN: The expense would, probably, be about £100,000. As to the publication of the returns of their traffic, they were, more or less at that moment, in a state of war with the French company, and the abandonment of the publication of their daily returns was somewhat equivalent to what was known on the Continent as a declaration of a state of siege. They did not want, while they were contesting or fighting with that company, to let them see their hands, and to show them what effect the diminution of traffic had on their income, and that was why they kept this information to themselves. He might tell them, as a matter of fact, that the traffic for January amounted to a very tidy sum, and he could assure them that they need not be the least alarmed. There was another question asked with regard to the balance at their banker's at the close of the year. The fact was that that balance consisted of bills not already due, and items of that description, which had probably all been received and paid away since. They must remember that it was then six weeks since the end of the year, and they were obliged to make their balances with their bankers; they debited their bankers with all bills lodged for collection and not yet matured. With regard to the bellicose observations of the gentleman who sat opposite [referring to Mr. Newton], he thought that before he sat down he would satisfy the meeting that that gentleman had not the slightest foundation for the oration he had made on that occasion. Mr. Newton, in the first place, said they ought to fight for their monopolies. Well, he was a free trader, and as such was opposed to monopolies, but, on the other hand, if they had a monopoly which was advantageous to this Company he should be very much inclined to put his free trade principles into his breeches pocket; but, unfortunately, they had never had a monopoly. The only thing they had approaching to a monopoly was that they had an undertaking from the British Post Office, and a concession from the French Government, giving to the Company any messages which might be sent through their wires, not directed to go by another cable. And so with North Germany. That monopoly was not interfered with in the least degree, if it were a monopoly. Well, that took away, as it appeared to him, the main foundation for the speech they had heard from Mr. Newton. But that gentleman went on to say that they had a partner, the Direct company, and three cables of their own, and asked why they did not make use of the advantages which that state of things gave them — why did they not carry at very low rates, and let their partner carry special messages at a higher rate? Perhaps it would surprise that gentleman very much to know that that was precisely the arrangement they had made. Therefore, all that magnificent eloquence in favour of defending their rights [expressions of dissent, and interruption]—he was speaking in the most good-humoured disposition, but Mr. Newton had made a speech in favour of what they had done, and what he meant was that they had done precisely what Mr. Newton had suggested should be done. He must say that the speech was made in a rather criticising manner; and when it amounted to saying that they ought to do what they had done he thought he had disposed of the speech. Mr. Newton further said that they ought to fight and not to cave in. He begged to say that as far as any utility could be got from fighting, he was as ready to fight as any man, but the caving in was not of their seeking. The other company came to them and offered them certain terms, and asked them if they would accept them. As he said at the beginning of the meeting, those negotiations were still in progress, and, as he heard a very distinguished statesman say on the previous night, nothing could be more mischievious to the result of negotiations than questions put when they were in progress. He must, therefore, adopt the same observation, but as to saying that they had caved in, he assured Mr. Newton and the meeting that if it were possible, without prejudice to the interest of the Company, to put them in possession of all that had taken place, they would find, so far from caving in, they were as stiff as they could be. He assured them that they would look after the interests of the proprietors in this competition, and act to the best of their ability. They had had some dark periods in their history before, and without arrogating any undue credit to themselves, he thought they had pulled them through pretty well. He, therefore, hoped that without further reference to competition and fighting, they would adopt the resolution, and leave the conduct of this matter in the hands of the directors.

Mr. NEWTON desired to remind the chairman that he had not asked a single question. He had the utmost confidence in them, knowing that they would preserve the rights of the proprietors. He had it, however, on the official paper of the Company, that the monopolies to which he had referred were monopolies. He had that among his private papers, and under the signature of one of the gentlemen sitting at the Board.

The CHAIRMAN then put the motion, which was carried unanimously. He next moved the re-election as a director of Mr. Francis A. Bevan.

Sir JAMES ANDERSON seconded the motion, which was carried unanimously.

On the motion of the CHAIRMAN, seconded by the Hon. ROBERT GRIMSTON, the other retiring director, Mr. L. M. Rate, was also re-elected.

Mr. JACKSON then moved the re-election of the retiring auditors, Mr. Joshua Dear and Mr. Francis Glass. He expressed his pleasure at submitting the resolution, and hoped the auditors would make any suggestion they properly could which would give the shareholders a slight increase to their moderate dividend.

Mr. SEELEY seconded the motion, and it was carried unanimously.

Mr. NEWTON then moved a vote of thanks to the chairman and directors. They knew how they were treated at some of the meetings of these companies, and he believed they would all agree with him that Viscount Monck bore off the palm among chairmen, for even when his lordship had anything unpleasant to say he said it in such a manner as to leave no feeling of irritation behind.

Mr. SEELEY seconded the motion, which was carried unanimously.

The CHAIRMAN, in acknowledging the vote, returned his sincere thanks to the meeting for the confidence they had reposed in their Board, and to Mr. Newton for the expression of his opinion of his (the chairman's) urbanity. He felt very much indebted to them, but he would ask them to include in the resolution the officers of the Company.

Mr. NEWTON requested that he might be allowed to include the officers, and threw out the suggestion whether some pecuniary recognition of their services could not be made, observing that it would go to pay the income tax of those gentlemen. He had spoken on some occasions in favour of economy, but he did not think economy should be exercised towards those who worked for them.

The CHAIRMAN again thanked the meeting, and the proceedings then terminated.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY (LIMITED).

The sixteenth ordinary general meeting of this Company was held on Thursday, the 12th inst., at the City Terminus Hotel, Cannon-street, under the presidency of Mr. George Henderson.

The SECRETARY (Mr. William J. Tyler) read the notice convening the meeting, and the report of the directors was taken as read. It stated that the directors considered the result of the Company's operations for the past year satisfactory. After deducting working expenses, depreciations, and bad debts, the net profit for the year was £52,354. Adding to this £9,048 brought forward from 1878 and £1,175 premium on new shares, and deducting £15,600 interim dividend paid in August and £2,100 written off shares in hand, there remained a disposable balance of £44,878. Of this balance the directors had added £25,000 to the reserve fund, raising it to £50,000; and they recommended the distribution of £15,600 in dividend for the last half year, being at the rate of 10 per cent. per annum, free of income tax, carrying forward £4,278. The interest on the Company's debentures and loans was moderate, and was more than met by the interest received on debentures and shares held. The new 6 per cent. debentures issued last March were all readily taken. The year's sales compared favourably with those of 1878. The Company's steamships had been well employed, the Dacia principally in laying the new cable of 500 miles from Marseilles to Algiers manufactured by the Company for the French Government and completed in October. Several smaller cable contracts had also been carried out during the year.

The CHAIRMAN, in moving the adoption of the report, said: The report is in your hands. It is not long, but I venture to think it is satisfactory, and so satisfactory, that I have very little to say in explanation. The profit amounts to £52,000, or about 17 per cent., and this has been secured after deducting all expenses, and a very ample sum for depreciation. The

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Company's works and ships are in excellent condition. Our name is well-known in the market, and our position as manufacturers of india rubber is second to none. The one little drawback is that the price of the raw material has advanced very heavily, while we find difficulty in persuading the public to pay more than formerly. Fortunately, we were fairly stocked before the rise. Our cable department has had some work, though not nearly so much as our appliances would enable us to do, but our general business is too good to make it advisable to risk our money in speculative ventures; and I regret to say much of the cable business cannot be obtained in any other manner. You will observe we place £25,000 to the credit of the reserve fund. In so doing, we have fulfilled our promise to the meeting of 1878. Several shareholders and our auditors then urged the immediate formation of a reserve fund. We, however, considered that a dividend should first be provided, but promised that any excess should be used for this purpose. Independently of this promise, the step is very desirable, as undoubtedly our capital is rather small for the extended business we are doing. I shall now be happy to answer any question that may be asked, and in moving the adoption of the accounts and report have great pleasure in congratulating you on the sound and valuable business you now possess. He moved "That the report and accounts now presented be received and adopted, and that a dividend for the past half year of 10s. per share, free of income tax, being at the rate of 10 per cent. per annum, payable on and after the 13th inst., be now declared."

Mr. S. W. SILVER seconded the motion.

Mr. D. H. SMALL referred to the issue of debentures in the last year, and asked if the directors had power to issue any amount of debentures, or were they limited. They seemed to have spent £9,000 on the property, which, notwithstanding constant writings off for depreciation, never seemed to decrease. He condemned the item of directors' fees, £5,000, as excessive, and moved an amendment on the subject.

Mr. NICHOLSON asked how the reserve fund was invested.

Mr. HANCOCK seconded the amendment, and pointed to what the directors of the Telegraph Construction Company had done. They were originally entitled, after 5 per cent. was paid to the shareholders, to £2,000 a year among six or seven directors. The directors afterwards came forward and said the remuneration was excessive, as the profits of the Company were more than they anticipated. They then proposed that they should receive no extra remuneration till 10 per cent. was paid, and subsequently they proposed another change. The position now was that the six directors received £2,000 among them, and were entitled to one-tenth per cent. of the profits over 10 per cent., but under no circumstances was that excess to be more than £5,000.

Mr. BAKEWELL strongly condemned the amendment, and contrasted the present position of the Company with its condition a few years ago, when, in consequence of the depressing circumstances which existed, the directors voluntarily gave up their remuneration.

In reply, the CHAIRMAN said the remuneration of the directors was fixed by the shareholders, and it was for them to alter it if they thought fit. For his own part he would have preferred being paid a percentage on the profits. The reserve fund was invested in the business of the Company. The directors were authorised to issue debentures to the amonnt of two-thirds of the capital; but they had no intention of issuing any more debentures than they had at present.

The amendment upon being put was lost, only the mover and seconder voting for it, and the original resolution was carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. KNOWLES, Messrs. S. W. Silver and N. Bannatyre were re-elected; and on the motion of Mr. SMALL, seconded by Mr. RANDALL, Messrs. J. Weise and J. Cowan were re-appointed.

Messrs. SILVER and BANNATYRE returned thanks for their re-election.

On the motion of Mr. LAMONT, a vote of thanks was passed to the chairman and directors, and the CHAIRMAN having briefly acknowledged the compliment, the meeting terminated.

THE CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).

Report of the directors for the half year ending 31st December, 1879, to be presented at the seventeenth ordinary general meeting of shareholders to be held on the 18th day of February, 1880. The directors beg to submit, duly audited, the balance sheet and accounts for the half year ended 31st December last. From these it will be seen that the gross receipts, including the balance brought from last account, amount to £19,972 15s. 10d., and the gross expenditure to £7,556 1s. 8d., leaving a sum of £12,416 14s. 2d. to the credit of revenue account. In the above amount of £7,556 1s. 8d., is included, however, the sum of £3,942 14s. 3d., the cost of the repair of the Cienfuegos-Santiago section of the original cable and of the cutting out of the fault in and other repairs to the india rubber (duplicate) cable, the ordinary expenses being £3,613 7s. 5d. These repairs were successfully accomplished by the Company's engineer, Mr. Keith, who has also within the last few days repaired one of the Cienfuegos Bay cables which gave way several months ago. The directors have further to report that a duplicate harbour cable four miles in length has been laid by Mr. Keith at Santiago. The sum of £3,500 has been added to the reserve fund, increasing that fund to £27,086 10s. 7d. The balance of revenue, after providing for the dividend on the preference shares, will admit of a dividend on the ordinary shares at the rate of 6 per cent. per annum, leaving the sum of £1,116 14s. 2d. to be carried forward to the current half year's account, and the Board recommend that dividends be declared accordingly, payable 19th instant.

TRAFFIC RECEIPTS FOR JANUARY, 1880.

COMPANIES.	Jan. 1880.	Jan. 1879.	Incrse.	Decrse
Cuba Submarine Company	3,200 estd.	3,043	157	—
Eastern Telegraph Company	48,887	39,226	9,661	—
Eastern Extension Telegraph Company	28,009	24,695	3,314	—
Great Northern Telegraph Company	17,280	13,876	3,404	—

TELEGRAPH SHARE LIST.

COMPANIES.	CLOSING PRICES FEB. 11.		BUSINESS DONE WEEK ENDING FEB. 11. Highest.	Lowest.
Anglo-American Ordinary	61¼,	62¼	63	61¾
Do. "B"	88½,	89	89½	88⅝
Do. "A"	35⅝,	36⅛	37⅛	35⅝
Brazilian	7 15-16,	8 1-16	8 1-16	7 15-16
Cuba	9,	⅜	9⅜	9
Do. Ten per Cent. Preference	16½,	17	16¼	16¼
Direct Spanish	2,	⅛	—	—
Do. Ten per Cent. Preference	11¼,	¾	11⅝	11⅜
Direct United States	11¼,	⅜	11¾	11¼
Eastern	9,	⅛	9¼	9
Do. Six per Cent. Debenture	103,	106	103¼	103¼
Do. Five per Cent. do.	101,	103	103	102
Do. Six per Cent. Preference	11 15-16,	12 1-16	12⅛	12
Eastern Extension	9 1-16,	3-16	9¼	9 1-16
Do. Six per Cent. Deb.	104,	107	105	105
German Union	8⅛,	9	8 15-16	8⅛
Globe Telegraph and Trust	5 11-16,	13-16	5 13-16	5⅝
Do. Six per Cent. Preference	11⅜,	⅛	11⅝	11⅜
Great Northern	9,	¼	9⅜	9⅛
Indo-European	24,	26	24⅛	24¼
Mediterranean Extension	3,	½	3⅜	3
Do. Eight per Cent. Preference	10⅛,	11	11	10⅛
Reuter's	10,	11	10⅝	10⅝
Submarine	235,	240	239	239
West India and Panama	1 15-16,	2 1-16	2 1-16	1⅞
Do. Six per Cent. Preference	8,	¼	8¼	7⅞
Western and Brazilian	7 11-16,	13-16	8 3-16	7 11-16
West. Union Seven per Ct. 1st Mt.	120,	125	—	—
Do. Six per Cent. Sterling	105,	107	—	—

ADDRESSES.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

PETER BROTHERHOOD, Engineer, 56 and 53, COMPTON-STREET, GOSWELL-ROAD, E.C.
Specialities—Patent 3-Cylinder Engines (Silver Medal, Paris), as used by Siemens, Gramme, and Wilde for driving Electric Machines.

RANSOMES, SIMS, and HEAD, Orwell Works, IPSWICH.
Specialities—Portable and Stationary Engines, fitted with patent governors, as tried in the electric lighting experiments on the Thames Embankment.

ABBOTT and Co., NEWARK-ON-TRENT.
Specialities—The "Standard Size" Vertical Cross Tube Boilers. Illustrated catalogue, giving every detail of a variety of Boilers, 2s. 6d., post free.

CARBON ELECTRODES COMPANY. Works: 39, COMMERCIAL-ROAD, EAST.
Specialities—Carbon Rods of all sizes for Electric Lighting. Also, Plates and all other Moulded Carbon Goods. List of prices on application.

M. THEILER & SONS, Telegraph Instrument Manu-facturers, 86, CANONBURY-ROAD, N. Works: ALWYNE-LANE, N.
Specialities—Morses, Polarised Relays, Saunders' Curb Keys, Type Printers, Recording Sounders, Duplex Apparatus (Theiler's Patent).

HOOPER'S TELEGRAPH and INDIA RUBBER WORKS, MITCHAM and MILLWALL DOCKS.
Contractors for the Manufacture and Laying of Submarine Telegraph and Torpedo Cables. Manufacturers of Hooper's celebrated Insulated Core. Printed reports on application. Offices: 31, LOMBARD STREET, LONDON, E.C.

THE BRITISH ELECTRIC LIGHT COMPANY (Limited), 41, PARLIAMENT-STREET, WESTMINSTER, and 17, WATER-STREET, LIVERPOOL.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

ESTABLISHED 1851.

BIRKBECK BANK.—Current Accounts opened according to the usual practice of other Bankers, and Interest allowed on the minimum monthly balances. No commission charged for keeping Accounts.

The Bank also receives money on Deposit at Three and a Half per Cent. Interest, repayable on demand.

The Bank undertakes for its Customers, free of charge, the custody of Deeds, Writings, and other Securities and Valuables; the collection of Bills of Exchange, Dividends, and Coupons; and the purchase and sale of Stocks and Shares.

Letters of Credit and Circular Notes issued for all parts of Europe and elsewhere.

A Pamphlet, with full particulars, on application.

FRANCIS RAVENSCROFT, Manager.

Southampton-buildings, Chancery-lane.

The Birkbeck Building Society's Annual Receipts exceed Four Millions.

HOW TO PURCHASE A HOUSE FOR TWO GUINEAS PER MONTH, with immediate Possession and no Rent to pay. Apply at the Office of the BIRKBECK BUILDING SOCIETY.

HOW TO PURCHASE A PLOT OF LAND FOR FIVE SHILLINGS PER MONTH, with immediate possession, either for Building or Gardening purposes. Apply at the Office of the BIRKBECK FREEHOLD LAND SOCIETY.

A Pamphlet, with full particulars, on application.

FRANCIS RAVENSCROFT, Manager.

Southampton-buildings, Chancery-lane.

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SLIP

CREUSOT.—It is announced that these immense works are shortly to be lighted entirely by electricity.

AUSTRALIA.—The commercial population of Victoria is complaining of the frequent interruptions of the Overland Telegraph line.

THE DIRECT UNITED STATES CABLE COMPANY.—The next ordinary meeting of the above Company is to be held on Friday, Feb. 27, at the Cannon-street Hotel.

THE TELEGRAPH IN JAPAN.—The Japanese Government telegraph line from Yokohama to Nagazaki, which is the longest in the island, has been duplexed. The Morse printer is the receiver employed.

THE GOVERNMENT AND THE TELEPHONE COMPANIES.—Dr. Cameron has given notice of his intention to call attention in the House of Commons on an early day to the action of the Post Office with regard to telephone exchanges, and to move a resolution.

THE ELECTRIC LIGHT AT THE BRITISH MUSEUM.—The trustees, it is said, are so well satisfied with the electric light in the reading room, that they have decided permanently to adopt it, and have ordered another dynamo machine of Messrs. Siemens Bros.

THE ELECTRIC LIGHT IN TURIN.—It is stated that a company has been formed of Italian capitalists for introducing the electric light into Italy, and that the company has made an offer to light with the electric light the streets of Turin during the forthcoming carnival.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.—The directors propose a dividend of 15 per cent., in addition to the interim dividend of 5 per cent. already paid, making 20 per cent. for 1879. At the corresponding period of 1878 the distribution was at the same rate.

CHESS BY TELEPHONE.—A chess tournament was recently played between the Brighton and Chichester chess clubs by means of the Edison telephone. The players sat in Brighton on the one hand and Littlehampton on the other, the telephone line connecting them being some 25 miles long.

EFFICACY OF BATTERIES.—M. Fromme finds that Grove's battery is most efficacious when the nitric acid contains 40 per cent. of water; the "strength" of Bunsen's decreases with the concentration of the acid; and that of Daniell increases with the concentration of the sulphate of copper solution.

COMPETITION.—The Western Union Company in America has a rival in the American Union Company. The latter was incorporated in May, 1879, and has now over 20,000 miles of line, and is still erecting at the rate of 1,000 miles a month. Its capital is 10,000,000 dollars. The President of the Company is General T. T. Eckert.

TRADE AND TELEGRAPHS.—Mr. Gladstone, in his article on "Free Trade, Railways, and Commerce" in the current number of the *Nineteenth Century*, includes among the causes which conduce to the increase of trade the extension of telegraphs. This is what Sir J. Anderson has been dinning into our ears for many years, and without a doubt it is correct.

MOZAMBIQUE CABLE.—The Eastern and South African Telegraph Company (Limited) announce the interruption of the Mozambique-Delagoa Bay section of their cable. The fault is reported to be near Mozambique, and the company's repairing vessel has already left Aden to restore the communication, which is likely to be interrupted for a period of about 14 days.

EDISONIA.—The *Operator* says, "The opinions of scientific men in Europe as to the ultimate success of Edison's light seem much divided." We thought otherwise; and it still seems to us that the scientific opinion of Europe is practically unanimous, and is that Edison has failed. In fact we have not heard of one solitary individual possessing any scientific standing in Europe who has expressed the opinion that Edison has succeeded.

ELECTRICAL MEASUREMENT.—It is announced that Prof. W. G. Adams, F.R.S., will give a course of six lectures on "Electrical Measurement in Relation to Telegraphy" in the Physical Lecture Theatre at South Kensington on the 5th 8th, 9th, 10th, 11th, and 12th of March, at 8 p.m. The fee for the course is £1 1s., but in the case of teachers a reduction of one-half will be made. Prospectuses, &c., can be obtained at the publication stall, South Kensington Museum.

UTILISING WASTE RUBBER.—The following method of utilising old and waste rubbers has just been patented in Germany. The rubber waste is subjected to dry distillation in an iron vessel over a free fire with the aid of super-heated steam. The product, when thickened and vulcanised in the usual manner, is declared to possess all the good quality of first-class natural rubber. It is recommended that the lighter oils which come over should be separated from the heavier products.

"PHILOSOPHICAL MAGAZINE."—The current number contains several electrical Papers, most of which have been read before the Physical Society—that describing Dr. Fleming's New Resistance Balance, also Dr. Lodge's Theory of the Induction Balance; besides which are papers on the Electric Light, On Magnets, The Temperature of the Voltaic Arc, Some New Luminous Tubes, On Thomson's Galvanometer, all but one of which appear among the Intelligence and Miscellaneous Articles.

NEW POST AND TELEGRAPH OFFICE FOR MADRAS.—Madras is likely soon to have new buildings for its post and telegraph offices. The Chambers of Commerce have wrought hard for this result, hitherto without success; but the last appeal has been vigorously taken up by the Duke of Buckingham, who, agreeing in the necessity for such a building, has asked the Government of India to provide the necessary funds in the official Budget for 1880-81.

AN "UNEXPLAINED" ELECTRIC EFFECT.—"If a hollow, open, metallic cylinder, capable of rotation round its axis is placed above a magnet of double the length in such a position that one of its extremities may coincide with the centre of the magnet, and the other with one of the poles, and if now a strong electric current is sent from one end of the cylinder to the other, it assumes a movement of rotation whose speed is independent of the resistance of the metal of which the cylinder is formed, and also of its thickness." This phenomenon is dependant upon the fundamental law of current-attraction.

THE TELEGRAPH IN THE UNITED KINGDOM.—The efficiency and activity of our English telegraphs is very well shown by a few statistics which are lying at hand. In 1878 America had 211,055 miles of Western Union Telegraph wire, Germany had 136,395 miles, France had 102,682 miles, Austro-Hungary had 86,087 miles, Russia had 89,154 miles, and Britain had 113,734 miles. But with all that mileage of wire America only sent some 25 million messages, while

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Germany sent about 11 millions, France 11½ millions, Austro-Hungary 6½ millions, Russia about 5 millions, and Britain 23 millions.

Society of Telegraph Engineers.—The following subjects for discussion and original papers are announced for the meeting of this Society, to take place on the 25th inst.:—Discussion on Mr. Augustus Eden's Paper on Morse Signalling by Magneto-Electric Currents. Discussion on Mr. Charles H. Wilson's Paper on Compensating Induction in Parallel Wires. On the Resistance of Galvanometers, by Oliver Heaviside, Associate. On the Variation of Electro-static Capacity in Submarine Cables, by J. B. Stearns, Foreign Member. On Testing by Received Currents, by H. R. Kempe, Member.

"La Lumiere Electrique."—In the current number of our excellent contemporary M. du Moncel continues his articles on "Multiple Transmitters," describing that of M. Baudot. This transmitter is designated as being one of the mechanical marvels of the exhibition of 1878, and as having brought its inventor a *grand prix* and the decoration of the Legion of Honour. The transmitter was described in 1877 in the *Journal Télégraphique*, and last year before the Society of Telegraph Engineers. M. du Moncel also contributes another long article on "Batteries," whilst M. Hospitalier continues his articles on "Measuring Apparatus."

A Cable to Bermuda.—Eight years ago a cable was being manufactured by Messrs. Hooper to connect England and New York, *viâ* Bermuda, that mid-Atlantic fortress of Great Britain, but the said scheme "fell through," and the said cable was laid along the coast of Brazil for the Western and Brazilian Company. The project is again revived, at least in part, for we understand that the question of establishing telegraphic communication with Bermuda is now being considered by the Colonial Office, the isolated position of that important station and naval depôt having been recognised by the Commission on Colonial Defence.

Electrical Storage.—Another novel secondary battery for electrical storage has been brought to the notice of the French Academy by M. D'Arsonval. In a vessel containing sulphate of zinc solution he immerses a zinc plate—or, better, a layer of mercury—and also a carbon plate surrounded with a quantity of lead shot. The current to be "stored" is sent through the cell from the carbon to the mercury. Zinc is deposited on the zinc plate, or, amalgamated with the mercury and peroxide of lead, is deposited on the shot, while sulphuric acid is left free. With a small cell of this kind containing only 1 kilogram of shot he worked a Deprez motor for four hours. The maximum electromotive force was 2·1 volts.

The Induction Balance.—A Committee of the Institution of Mechanical Engineers, formed to investigate the molecular structure of iron and steel, under the presidency of Dr. Anderson, have adopted the induction balance of Prof. Hughes as one of their instruments of research. The true nature of steel is by no means well understood, although its chemical composition is. What, for instance, is the condition of the atoms in tempered steel? To the elucidation of such questions the balance will, perhaps, contribute. While upon this subject we may add that Signor Guidi proposes to convert iron into steel by electric action; but since, in order to produce two tons daily, the continuous action of a dynamo-electric machine absorbing 120 horse-power is necessary, we do not see how the Signor will make it profitable.

Proposed Experiment with the Electric Light in Edinburgh.—At a recent meeting of the Cleaning and Lighting Committee of the Edinburgh Town Council, a proposal was made to introduce larger lanterns into the lamps in Princes'-street with the view of improving the lighting of that important thoroughfare. After full consideration of the subject, however, the committee, we believe, arrived at the conclusion that an experiment should be made with the electric light in the city, and for this purpose it was resolved to recommend the Council, at its next meeting, to authorise the committee to make the necessary arrangements for testing the electric light in Princes'-street, Waverley Bridge, and North Bridge. Those of our readers who know Edinburgh will understand how admirably some parts of this beautiful town will conduce to the success of lighting by electricity.

Telephones for Hospitals.—Some time ago we noticed the introduction of the telephone into the Children's Hospital at Pendlebury. Now we find the people of Birmingham are becoming acquainted with the convenience of telephonic communication for business and domestic purposes, and the committee of the Women's Hospital has been induced to adapt it for the increased security of the patients under their charge. They have commissioned Mr. Arthur H. W. Radcliffe to make a complete circuit between their in-patient department at Sparkhill, their out-patient department in the Priory, and the residences of the two surgeons, and this Mr. Radcliffe has undertaken upon most liberal terms. This arrangement will save a great deal of trouble, and will enable emergencies to be dealt with without loss of time; it will also entirely obviate any difficulty which may have arisen from the removal of the in-patient department to the country.

Lightning Rods.—Two Americans, Messrs. Prescott, profess to have discovered that underground currents of electricity, flowing in all directions, form the true "earths" of lightning discharges. They assert that all houses, trees, &c., struck by lightning are underflowed by these currents, and that no houses, &c., standing on spots where there are no currents are ever struck. In protecting a house from lightning stroke, therefore, their method is to test the ground underneath, and if there are no earth currents below to take no further trouble; but if these currents are present to earth the rod which they erect in the parts of the ground below where they are strongest. These gentlemen are also the authors of the electric divining rod which we mentioned recently, but they still leave us to divine what it can be, for all they will vouchsafe about it is, "we can show what can be done with it better than we can write." Is this another of those mysterious inventive forgeries which delude the "simple" Yankee so grievously?

The "Telegraph Trail."—After leaving the Forks—so called from the junction at this point of the Skeena and Watsonquah (British Columbia)—our course for a short distance lies along what is known as the "telegraph trail." Not that there is a telegraph line in operation in this part of the province, but a very extensive line was once projected in this direction. The Western Union Telegraph Company of America in 1865 commenced explorations with a view towards the construction of an overland telegraph, which, by way of Behring Straits, was to unite the old and new worlds. After the expenditure of three million dollars the scheme was abandoned, owing to the success of the Atlantic Cable. To construct and maintain this telegraph it was necessary to clear a wide track on either side of the proposed line, and this track is now known as the "telegraph trail." It extends for some distance north of Hazelton to a point known as Fort Stager, and before the project was abandoned the line had been built through a large portion of British Columbia,

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part of it, as far north as Quesnelle on the Fraser, being now in operation, the property of the Canadian Government. —*Good Words.*

TELEGRAPHIC COMMUNICATION FOR THE WEST COAST FISHING.—We understand that Sir James Elphinstone, M.P., has succeeded in getting the sanction of the Treasury to a work of some importance to the fishermen and curers of Aberdeenshire and Banffshire. Some time ago Mrs. Gordon, of Cluny, applied to have the telegraph carried on from Lochmaddy, in North Uist, to Loch Boisdale, in South Uist. There were considerable difficulties in the way, as the work involved the laying of several short cables. The importance of the fishery in that neighbourhood, however, has enabled Sir James to lay a case before the Chancellor of the Exchequer, which has resulted in the Post Office being authorised to conclude an arrangement with Mrs. Gordon, on the same terms as those accorded some time ago to the Duke of Sutherland, for land wires to Tongue and Lochinver. Information as to the early fishing at Barra has become urgently desirable, as it is attended by crews and curers or their agents from Peterhead, Fraserburgh, Buckie, and other ports on this coast; and all concerned are to be congratulated on the acquisition of a facility now so important as a means of successful fishing.

ANGLO-AMERICAN ELECTRICIANS.—We publish this week an exceedingly entertaining sketch of the "Pope Boys," from the pen of George Kirby Holmes, formerly of this town, who has known them intimately for many years. Their career has been a very remarkable one from the first; full of daring adventure, great undertakings, and brilliant achievements. Frank L. Pope is one of the highest authorities in matters pertaining to electricity and telegraphing, not only in this country, but in the world. It was to his ingenuity and personal daring that telegraphic communication was maintained with Boston during the New York draft riots, and to him also the geographical world owes almost its only knowledge of some of the most inaccessible regions of British Columbia. Ralph W. Pope, besides being prominently connected with general telegraphic affairs, the Gold and Stock Telegraph Company, the American District Telegraph and the Associated Press, has decided literary ability, and has done some capital newspaper work. Henry W. Pope was the practical organiser of the American District Telegraph, as it at present exists, and is now superintendent of of the Bell Telephone Company. Great Barrington has good reason to be proud of these sons. The full story of their lives has never before been told, and we have no doubt it will be read with great interest.—*The Berkshire Courier.*

A LECTURE EXPERIMENT.—Professor Spice recently measured, during a lecture, the velocity of a rifle ball fired across the stage. The distance was only 33 feet. Lieutenant Merriam co-operated, and his duty was to shoot away, with a Creedmoor rifle, two loose wires, each of which connected in an electric circuit two globules of mercury. One wire was placed just in front of the supported muzzle of the rifle, the other 33 feet distant. Two levers were arranged, with bent-wire points, over a piece of smoked glass to which a uniform motion could be imparted, and the electric connections were such that on the first wire being broken the point of the corresponding lever descended on the glass; but when the bullet broke the second wire it immediately rose again by the action of a spring. The result of this was that the point connected with this lever scraped a very short line on the smoked glass. The other point, being kept down during the swing of a seconds pendulum, scraped a longer space. After firing, the glass was withdrawn, and a magnified image of the lines thrown on a screen. The relative lengths of these lines were then ascertained, the longer being found 110 inches, the shorter 5 inches, making the duration of flight of the ball 5-110ths or 1-22nd of a second, its velocity being $33 \times 22 = 726$ feet per second. Those who have been at Woolwich during great gun experiments will easily recognise the modification of the method then used to determine the velocity of the projectile.

ELECTRICITY AND SURGERY.—Dr. Azzio Cazelli has received the gold medal of the Academy of Medicine of Bologna for a successful but extraordinary operation. The patient was a young woman, aged twenty, suffering from epithelioma. After the administration of chloroform, Dr. Cazelli commenced by performing tracheotomy by means of the galvano-cautery. He then proceeded to denude the larynx, which he carefully isolated and removed, with the cricoid, by the galvano-caustic loop. He then detached the pharynx as far as the tonsils, and amputated it; then divided the hyoid bone, removed the base of the tongue, penetrated the cavity of the mouth, detached the soft palate, and lastly excised the entire pharynx and both tonsils. The treatment consisted in deep suture of the hyoid muscles, the employment of the œsophageal bougie, the maintaining of the larynx of Trendelenburg's canula, and union of the two upper thirds of the wound. The operation, performed in accordance with Lister's plan, lasted three hours, and the loss of blood, thanks to the galvano-cautery, was almost *nil.* During the whole time the respiration, pulse, temperature, and colour of the face were satisfactory. A young Nice physician, Dr. Conguet, has just inquired of Dr. Cazelli, a fellow-student of his, with respect to the patient. The young surgeon informs him that he has been able not only to adapt to the patient a caoutchouc tube to replace the œsophagus, but that he has managed to invent an apparatus enabling her to articulate sounds.

A NEW ELECTRIC LAMP.—An electric lamp for use in workshops, railway stations, mines, collieries, and the like, the invention of Mr. C. W. Harrison, has been privately exhibited by the Sun Electric Light Company, at their experimental factory, 80, Gray's-inn-road, London. In this lamp carbon rods $\frac{3}{8}$in. in diameter, and placed vertically, are used, the positive being the top carbon and the negative the bottom one. The adjustment is stated to be automatic and not to consist of wheels, springs, or any similar clockwork arrangement whatever. What this adjustment does consist of, however, is known only to the inventor at present, particulars being withheld from the public in consequence of the foreign patents not having been quite completed. The light is a good, strong, and steady one, and on the light being extinguished through any accident, contact is instantly renewed. The light is about to be employed at collieries near Manchester and in South Yorkshire. The inventor claims to have solved the questions of divisibility of the current and modification of the light, and he proposes, after the foreign patents shall have been secured, to exhibit a number of lamps suitable for public and private purposes. Drawings were shown illustrating the principles of the proposed method of street illumination. This consists in the point of light being placed in the base of the lamp standard and directed up the interior of the lamp post, on the top of which is placed a circular reflector, by means of which the light will be reflected around. There were other modifications shown which will be best described when the principles of the invention are made known. The company are manufacturing their own carbons, which are understood to be made by a special process to insure uniformity in composition and so to conduce to steadiness of the light.

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TELEGRAPH OPERATIONS IN AFGHANISTAN.

The following official paper has been published :—

H.E. the Governor-General has read with pleasure the report of the able manner in which the telegraph operations connected with the campaign were conducted. No less than 420 miles of telegraph line were constructed and maintained beyond the frontier of the Empire in a manner that shows the organisation of the department to be good, and the staff effective. Every requirement of the Government has been promptly undertaken and efficiently carried out; and notwithstanding the large and sudden strain upon the resources of the department, the lines have been carried through without impediment of any kind.

The credit for the results attained is due, in the first instance, to the Director-General himself, and the thanks of the Government of India are tendered to Colonel Murray, with an expression of high commendation of the forethought and ability with which the operations of the department have been administered.

The immediate supervision of the construction of the lines was entrusted to Messrs. S. P. W. V. Luke, C.E. Pitman, and S. J. Josephs, officiating superintendents. These civilian officers cheerfully accepted the risk of life and hardships involved in such a service, and by their energy, tact, and readiness of resource carried through to a highly successful issue the arduous and dangerous duties to which they were called. The thanks of the Government of India are hereby tendered to these three gentlemen for the important services so ably and so loyally rendered by them to the State.

The thanks of the Government of India are also given to the following gentlemen :—Mr. W. R. Brooke, for the admirable arrangements made by him in his capacity as director of construction; Mr. W. K. D. Bignell, the superintendent of the Punjab Division; Mr. J. W. Duthy, for his excellent work in the Khyber Pass as assistant superintendent under Mr. Luke; Mr. N. Jones, for his excellent service in constructing the lines from Kohat to Thull, and from Peshawur to Jumrood.

The Government of India also notices with high approbation the conduct of Mr. Inspector J. Hutchins, attached to the Candahar Field Force Telegraphs, and generally of all officers and subordinates connected with these operations of the Department.

Order.—Ordered, that a copy of this resolution be sent to the Director-General of Telegraphs for information and communication to the officers concerned. And further, that the resolution and the Director-General's report be published in the *Gazette of India*.

A. Fraser, Major-General, R.E.,
Secretary to the Government of India.

Fort William, Dec. 18, 1879.

From Col. R. Murray, Director-General of Telegraphs in India, to the Secretary to the Government of India, Public Works Department.—No. 722 T., dated Nov. 5, 1879.

I have the honour to submit a brief report of the operations of the Telegraph Department in connection with the military advance into Afghanistan prior to the Treaty of Gandamuk. I attach the following detailed reports :—

I.—By Mr. Officiating Superintendent S. J. Josephs, in charge of telegraphs with the Kuram Valley Field Force. II.—By Mr. Officiating Superintendent C. E. Pitman, in charge of telegraphs with Candahar field force. III.—By Mr. Officiating Superintendent S. P. W. V. Luke, in charge of telegraphs with the Khyber field force; with an appendix.

Kuram Valley Field Force.

2. The Government of India letter, No. 359 T., dated October 3, 1878, requested me to make arrangements for the supply of 200 miles of semi-permanent line for the Kohat field force.

3. No time was lost in pushing up the stores to Kohat; and owing to the zeal and energy displayed by the construction officer, Mr. Assistant Superintendent N. Jones, the line was completed and an office opened at Thull, 66 miles from Kohat, on Nov. 8.

4. Mr. Jones was then relieved by Mr. S. J. Josephs, officiating superintendent, to whom had been entrusted the charge of the military lines in this direction, and who proceeded to Peshawur, where he constructed, with equal celerity and success, the short line from Peshawur to Jumrood.

5. Mr. Josephs was placed at the disposal of the general in command, and under orders received from him extended the line from Thull to Ali Kheyl by April 12, and eventually to Karatiga, 170 miles from Kohat. Offices were opened at Thull on Nov. 8, Hazar Pir on Dec. 26, Kuram Fort on Dec. 25, Peiwar on Jan. 10, Peiwar Kotal on March 19, Ali Kheyl on April 2.

6. The only casualties with Mr. Josephs' party were two muleteers murdered near Ali Kheyl.

7. The line was constructed with energy and judgment, was maintained practically without interruption, and after the early days of our occupation of the district, but little difficulty was experienced from marauders. The total length of working wire cut and carried away was fifteen and a half miles, a large quantity certainly, but inconsiderable compared with our losses in the Khyber.

8. Mr. Josephs carried out the important duty entrusted to him with complete success, and well deserves some special recognition of the excellent service he has rendered. This opinion is, I know, fully shared by Major-General Sir F. Roberts, K.C.B., who has, I understand, himself represented to Government his appreciation of the value of Mr. Josephs' assistance.

Candahar Field Force.

9. On Oct. 3, 1878, I was ordered by letter No. 359 T, to arrange for the supply of 250 miles of line to run along the line of communication through the Murri-Bugti country to connect Mittri with Rajunpore. On Oct. 22 this order was cancelled, and I was directed to send the material to Quetta for use, if required.

10. The difficulties experienced in getting these stores to Quetta were very considerable, but were overcome by the great energy and zeal of Mr. C. E. Pitman, the officiating superintendent in charge of telegraphs in Beluchistan.

11. Although the orders of Government were confined to the provision of these stores, I took the precaution of sending with the stores a staff sufficient to erect a line from Quetta to Candahar. Pending the arrival of the stores at Quetta, Mr. Pitman was engaged in making every possible preliminary arrangement for the possible extension, and on Nov. 29 he accompanied the agent, Governor-General, to Hykulzai to select a route and arrange for the protection of the line.

12. To Gulistan-Karez, forty miles, the line was completed on Jan. 8. Beyond this place its extension was not possible till Feb. 17, owing to the detention of the stores in the Bolan. Between Gulistan-Karez and Chaman, twenty-three miles, the line was constructed in five days, and an office opened on Feb. 22.

13. Up to this point Mr. Pitman had been under the orders of the agent, Governor-General; but it now seemed to me desirable to relieve him of the charge of the lines in Beluchistan, and leave him free to proceed with the troops under the orders of the General Commanding. I therefore arranged that the charge of the telegraphs in Beluchistan, including the semi-permanent lines just erected within the jurisdiction of the agent, Governor-General, should be taken over by Mr. Officiating Superintendent Boteler.

14. On March 6 Mr. Pitman received authority to commence the line towards Candahar, a distance of seventy-seven miles; on March 31 he opened the office in the citadel of Candahar.

15. The line, although so rapidly constructed, has worked without interruption, and only three known cases of wilful damages have occurred.

16. On March 28 Mr. Pitman's working party was attacked by a band of marauders, and Sub-Inspector Mahomed Sidi of this department and sepoy Nek Mahomed of the Sappers were severely wounded, and two camelmen slightly wounded.

17. Mr. Pitman's local knowledge and fertility of resource were invaluable, and his conduct of the whole expedition was characterised by the zeal and energy for which he has always been conspicuous. Equally with Mr. Josephs, he fully merits, and will, I trust, receive from Government some mark of its approval of this admirable service.

18. In paragraph 71 of his report Mr. Pitman brings to notice the very great assistance he received from Mr. Inspector J. Hutchins. Not alone as a telegraph subordinate officer has Mr. Hutchins distinguished himself; but as will be seen from the attached copy of letter No. 895 K, dated Aug. 11, from the Lieutenant General commanding the Candahar force, he displayed a rare courage and devotion during the severe outbreak of cholera among the troops at Abdul-Rahman, which called forth the admiration of Major Clifford, the road commandant, and the thanks of the Lieutenant General.

19. I much regret that in the grade of sub-assistant, the one immediately above that held by Mr. Hutchins, there is no vacancy to which I could promote him, but service so exceptional should not, I think, pass unrewarded, and I have the honour to recommend that, as a special case, he be promoted to the grade of sub-assistant, remaining supernumerary to the establishment until absorbed. The thanks of Government might also, I venture to think, be given to Mr. Hutchins.

Khyber Field Force.

20. On Nov. 13, 1878, I received an unofficial letter from the military department, inquiring as to the possibility of arranging for the construction of a line from Peshawur to Jumrood, and

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subsequently on to Dhakka, and on the same day I received a copy of military department letter to the Quartermaster-General, No. 867 K, conveying the formal instructions of Government for the erection of a line to Jumrood, to be advanced to the head of the Pass should it be entered and held.

21. Foreseeing the extreme probability of lines of telegraph being required in connection with the military advance *viâ* the Khyber, I had long previously on my own responsibility ordered up to Peshawur all necessary line material and office equipments, and had a qualified officer in readiness to push on at once as orders were received. The result was that on Nov. 21 I was enabled to open an office at Jumrood.

22. In anticipation of further orders, I then made complete arrangements for a considerable advance, and ordered to Peshawur, for charge of the work, Mr. Officiating Superintendent P. V. Luke, and a strong staff, directing him to report himself to the General Officer Commanding, Sir S. Browne, and to push on the construction of the line whenever permitted to do so.

23. From the fifth paragraph of Mr. Luke's report it will be seen that he was delayed at Jumrood for want of this permission from November 25 to December 26; on the latter date he received orders to advance, and within four days the line was erected to Ali Musjid, and an office opened there.

24. On January 8 he received permission to make the attempt to extend his line to Lundi Kotal, and succeeded in completing it and in opening the Lundi Kotal office five days later—viz., on January 12. On January 20 he had reached Dhakka and established the office there. The remaining offices were opened as follows:—Basawal, on February 16; Jallalabad, on February 18; Gandamuk, on April 24. And notwithstanding the enormous difficulties with which Mr. Luke had to contend, communication was almost uninterruptedly maintained.

25. Some conception of what these difficulties were will be gathered from Mr, Luke's interesting report, which shows that on a total distance of 108 miles of line it was cut ninety-eight times, and sixty miles of the working wire were carried away and never recovered. Had I not fortunately taken upon myself to order up stores for the whole line, and strengthen Mr. Luke's hands with a reserve of material calculated to meet every contingency, it is evident that telegraph communication on the Khyber line could never have been maintained.

26. The undertaking entrusted to Mr. Officiating Superintendent Luke proved to be in some respects more onerous than that of either Mr. Josephs or Mr. Pitman. It is impossible to overestimate the value of the tact he throughout displayed, or too highly to praise the zeal and devotion with which he applied himself to the execution of his difficult duty. How well he succeeded will be apparent from a perusal of the preceding remarks and of his own valuable report, and I have great gratification in bringing his name prominently to the notice of Government.

Lieut.-General Sir S. Browne, Lieut.-General Maude, and Major-General Tytler have each recorded their high appreciation of the value of Mr. Luke's assistance.

27. Mr. Luke speaks very highly of the able manner in which Mr. Assistant-Superintendent J. W. Duthy co-operated with him, and I quite endorse his remarks.

28. The experience of this campaign has shown conclusively the value of the system introduced by the late Director-General, and since largely extended, of spreading a knowledge of telegraphy throughout the Army, and employing soldiers as signallers in times of peace to fit them for this duty when required in field offices.

29. With each of the advance columns the large majority of the signallers were soldiers, and on the whole did the work really well (not nearly so well, of course, as thoroughly trained, experienced civil signallers, but the demand for men was sudden and large, and I could not have supplied the needful number of civilians without serious inconvenience to the service in India). The names of those who are especially mentioned by Messrs. Josephs and Pitman will be brought to the notice of His Excellency the Commander-in-Chief.

30. The supply and despatch of stores for the Khyber and Kuram Valley expeditions was greatly facilitated by the energy and zeal of Mr. W. K. D. Bignell, the superintendent of the Punjab Division, who from first to last spared no pains to assist the officers in charge with his greater experience and with material help. I have already expressed to Mr. Bignell my thanks for his unremitting exertions.

31. In conclusion, I may state that the total length of line constructed beyond the frontiers in connection with these operations amounted to 420 miles; and I venture to hope that the exertions of the telegraph department have proved of material assistance in the conduct of the war, and that the department has in no way fallen short of the expectations of the Government of India. ALEX. FRASER, Major-General, R.E.,
Secretary to the Government of India.

THE USE OF VOLTAIC BATTERIES.

We translate the following from *La Nature*:—

We are frequently asked which is the best voltaic battery. One may boldly reply to this question that almost all the forms of battery are good if they be properly applied. We here give, according to Mr. Sprague and our own personal experience, a list, which may afford useful indications in the majority of cases:—

For ELECTRO-DEPOSITION (COPPER, &c.)—Daniell, Calland, Smee, chromate of lime, bichromate of potash, Bunsen.

GILDING.—Daniell, Smee.

SILVERING.—Daniell, Smee, chromate of lime, bichromate of potash, Slater.

EXCITING ELECTRO-MAGNETS.—Chromate of lime, Bunsen, Slater, Smee, Daniel.

ELECTRIC LIGHT.—For experiments extending over a few hours, the Bunsen battery and its numerous modifications may be employed, also the chromate of lime, and Slater batteries.

INDUCTION COILS.—Bichromate, chromate of lime, Bunsen.

ELECTRO-MEDICAL.—Bichromate, Smee, Bunsen.

POCKET ELECTRO-MEDICAL APPARATUS.—Chloride of silver battery, sulphate of mercury, manganese, Trouvé's air-tight battery.

LONG TELEGRAPHIC LINES.—In this case batteries supply weak currents, passing through large resistances. The best are the chromate of lime battery, the Leclanché, sulphate of mercury, Daniell, Calland.

ELECTRIC BELLS AND TELEGRAPHIC LINES.—Leclanché, sulphate of mercury, sulphate of lead.

MINING OPERATIONS, TORPEDOS, &C.—The Leclanché battery may be used, but Breguet's exploder is most frequently employed. The small magneto-electric machine of M. Marcel Deprez is also excellent for this application.

MEASURING ELECTRICAL RESISTANCES, &C.—Chromate of lime, bichromate, Daniell, Leclanché.

EXPERIMENTS WITH HIGH TENSION ELECTRICITY.—The best results have been obtained with a large number of the chloride of silver cells of De la Rue, and with the secondary batteries of M. Gaston Planté.

For the sake of completeness we should mention THERMO ELECTRIC BATTERIES, which give good results in deposition of copper, gilding and silvering, and with which the electric light may now be obtained.

We have here mentioned only the best known batteries. It would have taken a whole number of *La Nature* to refer to all the known batteries which may give good results in the above applications.

THE DISRUPTIVE DISCHARGE.

After describing, in *La Nature*, the large induction coil constructed for Mr. W. Spottiswoode, President of the Royal Society, by Mr. Apps, M. Alfred Niaudet makes the following remarks:—

"We ask permission to conclude with an observation resulting from our own personal experience, and which we think may be novel. It is a well known fact that longer sparks are obtained between a point and a plate than between two points. It seems to us easy to explain why the former arrangement should be the best. Everybody knows that the sparks by no means pass in a straight line, especially if the distance they traverse is considerable. They follow a sinuous and capricious path, no two sparks taking the same path, or completely resembling each other.

"The path taken by the spark must be that of least resistance, and, in consequence of the motion of the air or small changes of the surface of the electrodes, this line of least resistance is constantly changing. If now we offer to the spark a somewhat extended metallic surface, such as that of a plate, the spark will not always follow the normal which is geometrically the shortest line. It often takes an oblique direction in which, by reason of almost unappreciable variations, the resistance of the air may be reduced. In popular parlance we might say that the plate offers to the spark a greater number of paths than would be offered in the case of two points, and amongst these paths that of least resistance is never the shortest.

"The peculiarity in the resistance of air is also met with in other bad conductors, and notably in glass. If we examine a plate of this material which has been pierced by the spark, we may see that the path is never a straight line, and sometimes branches may be observed which end in the substance of the glass, and which the electricity would seem to have abandoned after having essayed a passage in their direction."

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THE ELECTRICIAN.

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We cannot undertake to return drawings or manuscripts, and must, therefore, request Correspondents to keep copies.

All letters intended for insertion in THE ELECTRICIAN, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

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WIRE GAUGE.

For many years past it has been generally acknowledged that a uniform standard of wire gauge was a necessity. It is not difficult to understand how the existing chaotic system has arisen. A large number of drawers, drawing when wanted and just what was wanted, would commence with no system. Gradually it would be noticed that wire of particular gauges was more frequently asked for, and possibly drawers would at odd times work off a supply for stock. Purchasers finding that generally their requirements were more quickly supplied by this or that maker, more and more of the wire trade would in time gravitate to a few centres. The makers at these centres, having originally worked independently, would of necessity have different gauges. The facilitation of locomotion, and hence the extension of trade, would bring the various makers into conflict, and buyers would begin to find out more and more the inconveniences of so haphazard a system of measurement. Wire drawers when spoken to would acknowledge that a uniform system was necessary, but the question to be immediately answered would be, whose system, or what system, is to be the one adopted? Naturally, the makers will not of themselves adopt any one gauge, the pressure must be applied by the purchasers. When every specification adopts one system, makers must comply with the demands. If their gauge has previously differed from the one adopted, they will hasten to alter their draw-plates, and supply the demand under the new conditions.

The importance of this question is felt to be so great that several committees have been formed to report upon it, and the first of these to publish the results of its deliberations is that of the Society of Telegraph Engineers. The discussion is also being carried on in almost every Chamber of Commerce. Thus, at the last meeting of the Leeds Chamber it was agreed that Leeds should support the re-appointment of the committee on this subject, and in the discussion Mr. T. Kitson, the president, remarked that so delicate and minute a gauge should be constructed on scientific principles, and that, as far as possible, uniformity should be secured. This is exactly what the Committee of the Society of Telegraph Engineers advocates. The argument is to show that there is an urgent necessity and demand for a standard gauge, and that the gauge to be adopted should not vary materially from the present gauges now in use under the name of the Birmingham Wire Gauge and other similar names, as these gauges have been based on long practice and experience, and are well adapted to the practical requirements of trade. It is shown that the B.W.G. is extensively used abroad as well as in this country, and therefore any gauge adopted should be one that would satisfy the requirements of foreign purchasers as well as those of our own. It was in 1846 that Mr. Holtzapffel ascertained the dimensions in parts of an inch of good specimens of the B.W.G. of that time, and his measurements have been more or less generally accepted. The committee states that the different gauges now in use might be counted by hundreds. A few of the most important gauges are considered, and their best and worst features carefully stated. Thus we have those of Stub, Wynn, Cocker, Ryland, Walker, Watkins, Robinson, Matlock and Preece, Brown and Sharp, Clark, Briggs, Whitworth, &c. Keeping constantly in view the arguments put forward, the committee consider that the scientific gauge advocated by Mr. Latimer Clark is the one best suited for universal adoption. This gauge, which was in 1867, and again in 1869, brought before the notice of the British Association, follows very closely the sizes of the ordinary Birmingham wire gauges, while it has the advantages common to all geometrical gauges that it can be extended indefinitely in either direction for larger and smaller sizes, that a person knowing the weight or conductivity of any one size can readily calculate the others, that the differences are perfectly uniform throughout, that the half and quarter sizes can be defined with perfect precision, and that it is equally suited for English or foreign systems of mensuration. Mr. Clark's gauge is based upon a simple mathematical series, each number representing a weight 25 per cent. heavier than the succeeding one.

There is little doubt, when the facts of the case have been considered, that the recommendation of the committee is the right one. It is unnecessary for us to point out how important a uniform gauge is in telegraphy. This has been done over and over again. Mr. W. H. Preece, now the President of the Society of Telegraph Engineers, in 1872 ably described the difficulties arising from the existing state of things, and proposed a gauge based on regular increments of weight. We believe that a similar system was advocated about the same time by Mr. J. T. Sprague, but although there is much to recommend such a system, that proposed by Mr. L. Clarke is certainly to be preferred. As is pointed out in the report so often mentioned, the action of the British Association in relation to electrical units led to an almost imme-

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diate adoption of a uniform standard. The want was widely felt, the British Association gave what was required, and it was eagerly grasped. We believe a similar state of things would result if the Society of Telegraph Engineers, instead of waiting for other reports which may or may not be made, were to ask the Institution of Civil Engineers, the Institution of Mechanical Engineers, and the Society of Engineers to form sub-committees to confer with that which has drawn up so elaborate a report, and to consider if these societies could not at once stamp with authority a uniform system of wire gauge in like manner as the British Association stamped with authority a uniform system of electric units. Surely this is more a question for practical men, and more especially for engineers, than for purely scientific societies. If, then, these societies, which include among their members all the best known and most eminent of living engineers, combine to introduce a uniform system, and if each member in his specifications rigidly adheres to the system, the change from chaos to uniformity will present no difficulty. The leading engineers of the Continent would be glad to accept the system, and though America might hold out for a time, its citizens are too practical to linger long in accepting what they cannot but admit is of very great value.

CORRESPONDENCE.

THOMSON'S ELECTROMETER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A paragraph, describing an "improved" Thomson electrometer attributed to Herr Edelmann, is now going the round of the scientific papers, and is, I see, in *The Electrician* of Feb. 7.

Will you allow me to point out that the instrument was invented by Silone, and is described, with a drawing in *Pogg. Ann.*, 1875, p. 389.

The quadrants are tinfoil pasted inside a glass cylinder. The needle is kept connected to earth. The instrument is used for the determination of the specific inductive capacity of liquids, for if the cylinder is filled with any liquid, the deflection with a constant battery will be directly as the specific inductive capacity.

It gives results agreeing with each other to about one part in a thousand.—Yours, &c., J. E. H. GORDON.

ELECTRICAL ORNAMENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you kindly give me, through your issue of Saturday, an explanation of a method of causing "stars" (metal-foil) to scintillate by electricity. It is for a lady's fancy-dress costume representing "Night." Your answer would greatly oblige, yours, &c., J. BOSS.

Something light and compact would consequently be required.

[We have not seen the particular contrivance referred to; but probably it is analogous to the similar devices so cleverly arranged by M. Trouvé, in which the active agent is a small induction coil in connection with a minute portable battery.—ED. *E.*].

MAGNETIC CURATIVE APPLIANCES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have edited, besides the former *Electrician*, several journals, and therefore know how useless it is to argue with an editor in his own journal.

In your note to the letter on magnetic appliances I said that you spoke "dogmatically," because you relied upon theory. without having a practical knowledge of the subject. I am quite willing to allow that, from a theoretical point of view, your statement is correct, and for the same reason I for some years avoided the study of the subject, and, perhaps, had it not been from an accident should not have done so, but I was called in to a case of conjestion, almost amounting to inflammation of the lining membranes of the upper portion of the spinal cord, in a child, which I am convinced was produced by wearing, day and night, a very powerful magnetic spine band, and which immediately subsided on discontinuing the magnetic appliance.

You would be doing good service to science and the cause of truth if you would appoint a committee of, say, five, who would hear and consider evidence, and who would publish their verdict in your journal. I should be happy to form one of the committeee, or, if it were thought preferable, I would give evidence before it.—Yours, &c., HARRY LOBB.

51, Sackville-street, Piccadilly, Feb. 17, 1880.

ELECTRO-DYNAMIC ACCUMULATION.

THE CHRONOPHER OF MR. C. F. VARLEY, F.R.S., M.I.C.E., &C.

(CONTINUED FROM PAGE 148.)

III. THE COMMUTATOR.

This is an apparatus by which the different provincial lines are disconnected from the ordinary telegraph instruments and joined to the relay, which transmits the "time current" through them. The provincial line wires are brought to a series of tumblers, which in their normal condition rest on stops in communication with their respective instruments. In front of these tumblers is an excentric barrel set in motion by an independent and slow moving train of clockwork, with a balance escapement. This barrel is in permanent connection with the bar of the relay through an extra tumbler, which presses on the barrel in front. The clockwork is stopped by a catch which falls into a notch in the wheel which revolves with the barrel. This catch is at the end of the lever of an electro-magnet. When the electro-magnet is brought into action it unlocks the wheel and the clockwork starts of itself; the contact is continued long enough for the notch to get well clear of the catch, and then ceases. The revolution of the barrel takes place in three minutes, and during this time the lines are disconnected from their instruments, connected to the relay for about a minute before and after time is sent, and on the completion of the revolution the clockwork is again locked and the lines again connected to the instruments. At the extreme right of the barrel is another small excentric, insulated from the rest of the barrel, but revolving with it. This excentric is exactly the reverse of the other, so that whilst the provincial lines rest on their stops, it keeps the two tumblers on which it acts raised off their stops, and metallically connected together. One of these tumblers is connected to the Greenwich wire after it has passed through the relays, the other is connected to the wire leading to the General Post Office and Westminster Clock Tower. When all is at rest, these two tumblers being joined together, the Greenwich wire is through direct to Westminster. At 10 a.m., however, when the barrel is revolving, this connection is broken, and the two tumblers let down on their stops; the stop of the Greenwich tumbler communicates with the earth direct, the other with the local relay. The effect of this arrangement therefore is that at 10 a.m. the Greenwich line being put to earth, all chances of failure in the numerous clocks, connections, &c., and and street wire between the central station and Westminster, are avoided; the Westminster wire being joined to the local relays still, however, receives a "time current" as at other times. The great importance of the 10 a.m. current renders this precaution very necessary. In the principal instrument room is a loud sounding bell which strikes by a current from the local relay. This bell is only required to strike once a day, viz., at 10 a.m.; and in order that it may be silent at all other times the following arrangement is made:—The wire which comes from the local relay to the bells, is brought to a terminal in connection with the pillar, limiting the upward play of the magnet lever which starts the excentric barrel; here it has the choice of two routes. When all is at rest, these two routes are both connected, and the current, of course, passes through that having the least resistance, and the bell remains silent. At 10 a.m., however, the lever being depressed, the short circuit is broken, and the current consequently passes through and strikes the bell.

IV. THE RELAYS.

The two relays used in connection with the chronopher have hitherto been mentioned as the "provincial" and "local" relays. These relays are similar to those in use on the lines of the Electric Telegraph Company. They are known as Varley's horizontal relays, and are constructed as follows:—A bar of soft iron mounted on a centre pivot is free to make a

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slight oscillation inside two coils of wire. Outside and at the ends of these coils are fixed two permanent magnets. The bar will rest at one side or the other as it is placed nearer or further from either pole of the magnets. When a current is passed through the coils in one direction the bar is converted into an electro-magnet, and is attracted by the north pole at one end and repelled by the south pole at the other end. A current in the reverse direction exactly reverses the motion. The bar is in this case placed a little out of the centre, and is always attracted to one side, except when a current is passed through the coils. One end of the bar oscillates between two screws tipped with platinum, at this point the bar is furnished with spring contacts, so that a jar will not interrupt the connection. In the ordinary relays a contact is only required at one side, the back screw being tipped with glass or agate; in these relays, however, contact is made at both sides. The principal advantages of these relays are:—

I.—There is no spring adjustment whatever.

II.—When once adjusted they will work for a very long time without attention.

III.—The bar having no magnetism of its own can never be demagnetised by a flash of lightning, &c.

The Greenwich current when the relays are in circuit, passes first through the coils of the provincial relay, and then through those of the local, going on at 10 a.m. to earth direct, and at all other times to Westminster.

V. The Switches.

One of these switches is in the same case as the commutator, the other is a separate piece. The object of the first is to cut the relays out of circuit at all times, except for a few seconds before and after each hour. This arrangement reduces the chances of a false signal to a minimum, and prevents the clock-setting currents which pass between the Observatory and the post offices during the forenoon from ringing the bells connected with the chronopher. From the point where the Greenwich wire enters the first relay a wire is brought to the pillar of the switch. From the point where the same wire leaves the other relay a similar wire is brought to the lever of the switch. When all is at rest the lever and pillar are in metallic connection, consequently any current arriving chooses the route through the switch instead of that through the relays, in consequence of the greater resistance of the latter, and no effect is produced in the chronopher. The other switch is used in connection with the Newcastle time arrangement, for as Newcastle requires "time" twice a day this line cannot be attached to the commutator. The Newcastle line wire is connected to the lever, the ordinary instrument to the front pillar, and the back pillar to the bar of the provincial relay. It is, therefore, evident that when all is at rest the line wire is joined to the instrument; when the lever is depressed the line is disconnected from the instrument and joined to the relay.

VI. The Galvanometers.

The first galvanometer is inserted in the Greenwich wire before it reaches the relays. It serves to indicate the passage of the current *in* from Greenwich. The other galvanometer is inserted between the provincial relay and the commutator or Newcastle switch. It shows the passage *out* of the current to the provincial stations.

Manner of Action.

The gradual revolution of the twenty-four hour wheels brings the two 10 a.m. notches under the ends of the levers, and about twenty minutes to 10 they fall into the notches, allowing their upper ends to rest on the hour wheels. At 9h. 59m. 20s. the platinum piece in the back hour wheel comes in contact with the commutator lever, a current flows from battery No. 1 through the coils of the starting magnet, and, depressing the lever, allows the clockwork to start; the barrel then commences to revolve. This contact is only continued about twenty seconds, so as to allow the wheel to well clear the catch. At 9h. 50m. 30s. the platinum piece in the hour wheel comes into contact with the Newcastle lever, a current flows from battery No. 2 through the Newcastle switch, which disconnects the Newcastle line from the instrument and joins it to the relay. About twenty seconds after the barrel has begun to revolve, the lines are connected through it with the bar of the relay, which being at rest, a zinc current from battery No. 3 flows into them. This zinc current flows into the Newcastle line immediately the switch is acted upon. About twenty seconds before 10, and every other hour, the insulated pin in the back hour wheel lifts the seconds lever up, and at about nine seconds to 10 the gold tipped piece commences to make a rubbing contact with the gold spring, sending a current through the coils of the relay switch, which puts the relays into circuit. The contact at the gold spring is necessarily a very delicate one, and it was found did not give a perfectly continuous contact, from the tendency of the gold spring to vibrate, producing a series of short disconnections. This difficulty is obviated by keeping the spring wet with chronometer oil. All being now ready for the receipt of the current, on its arrival from Greenwich it passes through the two relays, and thence to earth. This current lasts one second and a half. The provincial relay being acted upon sends a current through all the provincial lines. The local relay, in like manner, sends a current through the local lines. About nine seconds after 10 the contact ceases at the gold spring, releasing the relay switch, and again cutting out the relays. At thirty seconds after 10 the Newcastle contact ceases, and the line is again joined to its instrument. At 10h. 1m. 20s. the barrel of the commutator having completed its revolution, the catch falls and locks it, the lines being once more joined up as usual. At 1 p.m. the same operation takes place as far as Newcastle is concerned, there being a second notch in the front twenty-four hour wheel which allows the Newcastle lever to complete contact. The commutator does not, however, act except at 10 a.m. The local relay sends a current *every hour* to the local stations, and an arrangement can be made to send time to any single station in connection with the chronopher at any hour of the day when necessary. It will be evident from the foregoing description that the clock must never be allowed to be more than nine seconds slow or fast. As a matter of fact it is never anything like so much out. All the points of contact in connection with the chronopher are in platinum, in order to ensure perfect electrical communication.

PHYSICAL SOCIETY.

Annual General Meeting, February 14th, Professor W. G. Adams, President, in the chair.

The President read the report for the past year, which showed that the position and prospects of the Society were in every way satisfactory, and that more papers had been read during the past than any previous year. Sir William Thomson was chosen president for the ensuing year, and various other officers were elected. Votes of thanks were also given to the Lords of the Committee of Council on Education, to the treasurer, demonstrator, and secretaries. The meeting was then resolved into an ordinary one, and the following new members were elected:—Mr. Mollison, Mr. Hare, Mr. J. C. Lewis, Miss Caroline Martineau, and Senor Roig y Torres, of Barcelona.

Papers were then read on "A Quartz and Iceland Spar Spectroscope, Corrected for Chromatic Aberration," by Dr. W. H. Stone. The spectroscope consists of two Iceland spar prisms and a quartz train. It differs in no respect from those ordinarily made, except in the fact that the object glasses of telescope and collimator are doublets, with a positive lens of quartz, and a negative of Iceland spar. The latter has a dispersive power so far greater than that of quartz, that an approximation to achromatism may be easily obtained. Of course, in a spectrum there is less fear of indistinctness from superposition of images than in a telescope; but a greater amount of focussing is required with unachromatized lenses, insomuch that lines in the field at one time need alteration to obtain distinctness. Moreover, it is an obvious advantage to transmit the whole of the rays coming from the collimator as nearly as possible parallel through the intra-objectival space and the prisms.

The object glasses were made by Mr. Abrens about four years ago, and sent to Professor M'Leod. They were put aside, but have been recently mounted in consequence of M. Cornu having recently published a similar device.

A paper was then read on "An Automatic Switch," by Mr. Wynne. This instrument was designed for telephonic circuits, to enable a member of the Telephone Exchange to communicate with any one of the other members through the central office without the co-operation of an assistant in that office. Criticisms were made by Mr. Varley and Prof. Ayrton, the latter thinking that the contacts in Mr. Wynne's arrangement were such as not to be always reliable.

Professors Ayrton and Perry then read a note on the "New Theory of Terrestrial Magnetism," first propounded by them last spring at a meeting of the Society. Prof. Rowland, of Baltimore, had pointed out an error in their calculations which vitiated their result. The authors admitted that the charge of statical electricity on the surface of the earth, which they had assumed to be competent to account for the earth's magnetism, was not competent to account for the whole of it, but only a portion of it. Nevertheless, they thought that the changes in the distribution of such a charge due to changes in the condition of the dielectric medium between the earth and the sun might account for the observed perturbations in the magnetic elements.

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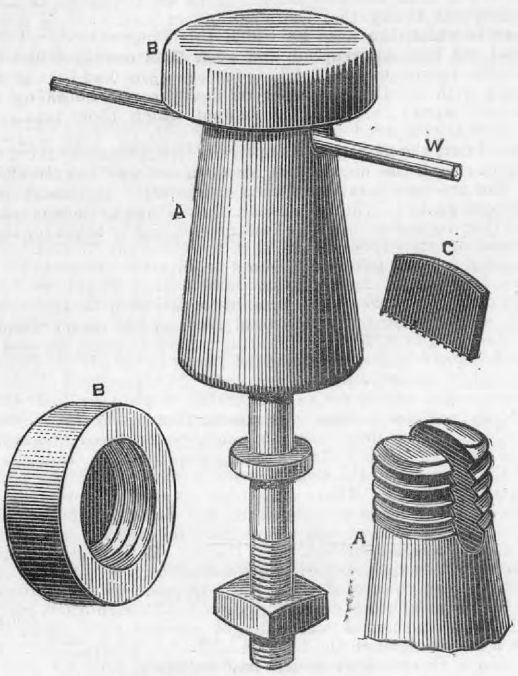
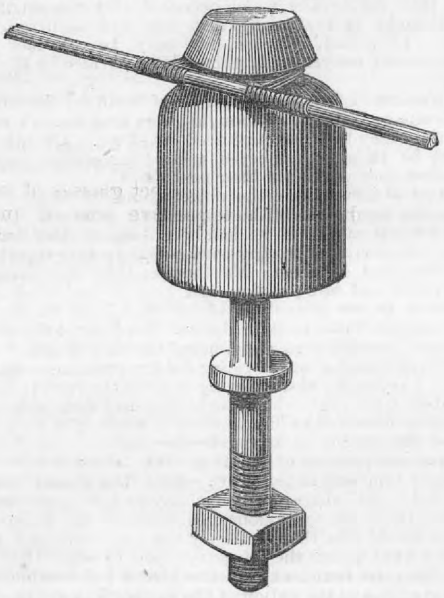
CRIGHTON'S INSULATOR.

The insulator illustrated in the annexed Fig. 1 is of the form



most used by the Postal Telegraph Department. In this the porcelain cap is grooved. and the telegraph wire held by binding wire firmly attached to it and passing round this groove. This binding takes some time, and in some districts the binding wire is rapidly corroded and the attachment destroyed. In the new insulator—the invention of Mr. C. E. Crighton, of Newcastle—the porcelain cap is made in two parts, A and B, as shown in Fig. 2.



The upper part of A is slotted and screwed, as shown by detached sketches, and a strong porcelain cap, B, screws thereon. The telegraph wire W is simply dropped into place, the serrated steel wedge E dropped into the slot, and the cap screwed on. The wire is by this means held so tightly that the ordinary lengths may be suspended by its grip.—*Engineer.*

SIR CHARLES WHEATSTONE.

(A discourse delivered by Mr. W. H. Preece, at the Royal Institution, on Friday evening, 13th February, 1880.)

Dr. Johnson said of Oliver Goldsmith—

"*Nihil erat quod non tetigit;*
Nihil quod tetigit non ornavit."

Some are inclined to think that the great literary giant of one hundred years ago thought more of the roundness of his periods than of the facts they clothed, but a greater man than Samuel Johnson said of a greater man than Oliver Goldsmith—in fact, our well-beloved Faraday said of Charles Wheatstone that there was nothing he touched that he did not adorn.

Wheatstone's familiar form was very well known to the old *habitués* of this theatre. Whenever either of his favourite subjects, light, sound, or electricity, was under discussion, his little, active, nervous and intelligent form was present, eagerly listening to the lecturer. He was no lecturer himself, yet no one was more voluble in conversation. At explaining any object of his own invention, or any apparatus before him, no one was more apt, but when he appeared before an audience and became the focus of a thousand eyes, all his volubility fled, and left him without a particle of that peculiar quality (which perhaps a schoolboy would call cheek) which enables an individual with confidence to come before a critical audience, such as is represented by the members of this institution, to develop scientific facts or describe apparatus. This defect proved fortunate, for it was the cause of Wheatstone obtaining the aid of the greatest lecturer of the age, and the annals of this institution bear record of many a Friday evening being occupied by Faraday expounding the "beautiful developments," as he called them, of Wheatstone.

Up to the year 1834 Wheatstone devoted his time almost entirely to the investigation of sound. In that year he was appointed professor of natural philosophy at King's College, and then commenced that career of electrical investigation, that wave of success on whose crest he moved until it broke on the shore "of that country from whose bourn no traveller returns." The many electrical inventions by Wheatstone which were brought forth after 1834 were derived more or less from his telegraphic achievements. He was not an electrical investigator; no one could be while Faraday existed. He was what Faraday was not, a practical man, who applied the discoveries of others to the wants and purposes of mankind. Somebody has said that nothing is easier than the discovery of yesterday. Nothing is more difficult than the discovery of to-morrow! The telegraph itself was no new idea. The scroll of time bears the names of Lomond, Le Sage, Sommering, Ronalds, Ampère, Schilling, and others, but it was only in the year 1837 that all these finger posts led up to that point where two men met who made telegraphs practical. In 1837 Cooke, Morse, Steinheil, and Wheatstone all focussed the labours of previous inventors, and gave the starting point towards making telegraphy what it is. Cooke and Wheatstone went hand in hand. Wheatstone was the brilliant, fertile, ingenious man of science. Cooke was the sanguine, energetic, practical man of business. When Cooke came to England from Heidelberg he was (through Dr. Roget and Faraday) brought into contact with Wheatstone, and he found that Wheatstone had cracked the Columbus egg—he had discovered the possibility of bridging over space. All previous attempts to apply electricity to useful purposes had failed, from the difficulty of obtaining sufficient force at a distance to be productive of effect. By applying the laws of Ohm to the facts of Ampère and Oersted, Wheatstone succeeded in finding the proper basis for arranging wires and magnets in such proportions as to produce evident effects. The electrical effects utilised for telegraph purposes are very numerous. The one upon which Cooke and Wheatstone worked was the simple fact that whenever a current of electricity passes in the neighbourhood of a magnet, such as the mariner's compass, that magnet was deflected; and Wheatstone arranged five mariners' compass needles in a horizontal row, each needle deflecting when a current of electricity was sent along the wire to which it was attached, deflecting to the right or left according to the direction of the current. Such deflections or beats to the right or left represented symbols, combinations of which could be translated into letters and words. Here is a five-needle hatchment-shaped instrument, made on the principle I have just explained. This was the original kind of speaking telegraph instrument. It soon became apparent that five needles were not required to form symbols representing all the letters, and a four-needle instrument was introduced, and practice and experience, the great utility tests, proved that when one or other of these four needles became faulty or unworkable, communication could still be readily kept up on the remaining needles. Thus it was soon found that a double-needle instrument was capable of meeting all requirements, and here before you are instruments of the original design on the double-needle principle. This one of an elegant architectural design was made for use in the House of Commons about 1850. Before you are the first two double-needle instruments that were ever used, and they are greatly prized for their historical value. This kind of instrument met the same fate as its predecessors, and was superseded by a single-needle instrument which gave out its signals quite as efficiently as its earlier brethren possessing a greater number of needles. This form has remained in use at the present day, and may be seen at any railway station in the country. It is used to a greater extent than any other kind of telegraph instrument, there being at the present moment at least 10,000 employed by railway companies, and 3,500 by the Post Office. It is an instrument of simple construction, but I will not detain you by explaining details. You can easily see that when I press down a pedal the needle is deflected, if it be the right hand pedal then the needle goes to the right, and if the left hand pedal it goes to the left, and one deflection to the left, and one to the right represents the letter A, one to the right and three to the left B, four beats, one right, one left, one right left C, and so on through the alphabet. Wheatstone saw the necessity of doing away with the trouble of acquiring familiarity with this kind of instrument, and set to work to introduce one which could be understood by anyone in a moment's acquaintance. This, of course, meant representing the ordinary letters of the alphabet without requiring translation from signals. He produced an instrument which printed the ordinary letters, but the mechanical complexity of its arrangement compelled him to abandon it. He then thought of a permanent alphabet on a dial which revolved in front of an open window or around which the indicating needle could revolve and point out the exact letters sent. This proved more practicable, and the result was the alphabetical instrument. such as I now show you. The indicating portion works in a very similar manner to the second hand of an ordinary clock. In a clock the hand makes a slight pause at each point, representing a second on its dial, and proceeds by jerks round and round the dial, being stopped at each second by the cogs of a wheel. The hand or indicator of an alphabetical instrument, works round the dial containing the alphabet just in the same way, but is controlled by a piece of mechanism which only answers to the current being sent. Each current moves the mechanism to which is attached the indicating needle, and each movement jerks forward the needle one step as it were. To cause the needle to make

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one revolution round its dial we will suppose requires fifty-two steps (really it is many more). Then if it is made to wait or rest at every second step, and opposite that step a letter is placed, it is easy to see that in one revolution all the letters may be successively indicated. The indicator is caused to rest or wait by the depression of small keys placed round the dial of the sending portion of the instrument opposite to the printed letters. The whole apparatus is based on one of the most remarkable discoveries of this century, that by which Faraday found it possible to obtain electricity from a magnet. I have here the identical apparatus that Faraday himself used in developing this beautiful idea. It was not an accident (none of Faraday's discoveries were accidental), but it was the result of continued self-education, scientific training, experience, and observation, and forms one of the most interesting episodes in the scientific history of this country. Faraday, by taking this magnet and placing over it a soft iron armature, around which wire is wound, was able to produce electricity on moving the magnet backwards and forwards. He thus caused currents to flow in the wire round the armature, which produced sparks as you see I now do. The following lines were written upon this experiment:—

"Around the magnet Faraday
Was sure that Volta's lightnings play,
But how to draw it from the wire?
He took a lesson from the heart.
'Tis when we meet, 'tis when we part,
Breaks forth the electric fire."

Wheatstone applied this fact first of all to produce artificial alarms. Here is an instrument (which old electricians call a "thunderpump") containing an arrangement similar to that used by Faraday, the magnet being caused to move by the pressure of a handle. The ends of the wire round the armature are joined to an alarum, and on my pressing down the "pump" handle you hear the bell ring, which is caused by the electricity produced, and sent along the wire by the moving magnet. The bell might be fifty miles away, but the effect would be the same. The same idea was again adopted, and a wheel (like a ship's steering wheel) was made to send a current every revolution. A case is marked off with the letters of the alphabet, and the wheel is made to stop opposite the letter sent. This apparatus was used in 1840. It was too cumbrous for practical adoption, and so fell out of use. From then to 1850 little or nothing was done, but in that year Wheatstone introduced quite a novel feature in the manufacture of his instruments in the way of making them of the most perfect mechanism, and as accurate in their fittings as chronometers; and to enable this to be done he fortunately succeeded in acquiring the assistance of perhaps one of the finest mechanical geniuses and workmen that England has had for many a long day; and that is Mr. Stroh, whose name I need not say is well known to this institution. Here is a specimen of the improved alphabetical transmitter. When the handle is turned, currents of electricity are produced which, when the keys opposite the letters are pressed down, go to the other end of the wire, to which is attached the receiver or indicator, the needle of which moves according to the currents sent. (The method by which the indicating needle revolved was explained by the use of a large model with toothed wheel and springs; and when the actual mechanism of the sending portion of the alphabetical instrument was reflected on a camera screen the principle of the instrument was clear.) I have shown you the primitive instrument of 1840, and its improved though cumbrous form of 1858; and here is its elegant representative of 1880, which is joined up to a wire between this room and the Central Telegraph Station, and by which we will have a little conversation. There is scarcely a portion of this instrument that is not an improvement on the earlier forms, and some of the improvements have passed through many stages before reaching their present perfection. The original principle adopted by Wheatstone remains, but the teachings of practice and observation showed practical defects which have been removed, and so brought the instrument to what you now see. (Several items of general news were received on the alphabetical instrument from the central station.) While this instrument is slow, it is sure, and, comparing its pioneer of 1840 to a carthorse, may be said to be a fine racer. It is very useful for private purposes or at outlying offices where little business is done; and many thousands of them are so employed.

(TO BE CONTINUED).

CUBA SUBMARINE TELEGRAPH COMPANY.

The seventeenth ordinary general meeting of the shareholders of this Company was held on the 18th inst. at the offices, Old Broad-street, Mr. T. Hughes, Q.C., the chairman, presiding.

The SECRETARY (Mr. James Scott) read the notice convening the meeting; and the report of the directors, the salient features of which appeared in *The Electrician* of last week, was taken as read.

The CHAIRMAN in moving its adoption, together with the accounts, said he was sure that the shareholders would have seen with pleasure that the business of the Company, although not making any great advance, as could hardly have been expected in such a year as the past, had nevertheless made a very fair advance. The sum earned during the past half year exceeded by over £2,000 that which was earned in the corresponding period of the previous year. Under these circumstances the Board had had again carefully to consider the question which had been raised on previous occasions—whether the dividend on the ordinary stock should not be increased. After mature consideration they had come to the conclusion that the wiser course was to recommend that the dividend which had been paid during the past few years should be at present adhered to, notwithstanding the increase in their business. It seemed to him that any shareholder who would cast his eyes upon the comparative statement of traffic which the directors had circulated with the report would agree that the Board had exercised what was only a sound and careful discretion in the matter. The longer their experience extended over the business of telegraph companies in that quarter of the world, the more clear it became that very large allowances must be made for the casualties which were incident to that kind of property. Looking at the comparative statement, they would see that during the past year there were no fewer than thirteen interruptions on the cables of lines beyond theirs—that was to say, that there had never been a single month in the past year in which the lines on which this Company depended for their traffic had not been interrupted, and even their own lines had been interrupted twice during the year. These interruptions had been most successfully dealt with by their engineer on the spot, and he thought that the shareholders would feel that the amount which those repairs had cost them, £3,942, compared very favourably with the cost of past repairs, and showed that the management upon the spot, especially the management in connection with the engineering department, was in extremely efficient order. But the consideration of that comparative statement had brought the directors again to the conclusion that it was quite necessary in their business that very considerable allowances should be made for the constant occurrences of interruptions, and that the Company, in fact, would not be in a thoroughly satisfactory and sound business position until it possessed a reserve fund of not less than £50,000. They would see by what the directors proposed to do on the present occasion, with the shareholders' sanction, which he trusted they would receive, the reserve fund would be at once increased to £27,000, and having regard to what he said he hoped the shareholders would concur with the Board in the advisability of limiting the dividend for the present to 6 per cent. In all respects their prospects were good for the coming year. The traffic of the year had opened most satisfactorily, and their lines were now in thoroughly satisfactory order. Not only had the long lines been thoroughly overhauled and repaired, but the old harbour cable had also been repaired, and he thought he might say that the property of the Company was never in a sounder position than at the present moment. There were also good prospects from the great activity which had been awakened in the isthmus of Panama by the proposals of M. de Lesseps and others for undertaking at once the great work of cutting a canal through the isthmus. Of course, operations there would greatly affect the prosperity of the Company, as well as of other companies which were connected with the isthmus. Their relations with the Spanish Government were exceedingly good, although they had one question in debate with them of a considerable amount, as to which they hoped to obtain a return through the decision of the law courts there. They were dealing with a Government which had certainly behaved very well and justly with them, but at the same time it was a very poor government, and it was exceedingly difficult to get a return on any sums which they might owe to companies of this kind. He then moved the resolution.

M. JOAQUIN DE MANCHA, a director, having seconded the motion,

Mr. NEWTON asked whether the low rates now charged by the Anglo-American Telegraph Company had benefited this Company. He asked whether it would not be advisable, in the excellent sheet they published, giving the monthly details so fully—in the issue of which he said they set a splendid example to other telegraph companies, none of whom yet adopted it—to show that the breaks which occurred were not on this Company's lines. He thought at first sight that they had occurred on this Company's lines. They had, however, had only two—a fact on which he thought they could congratulate themselves, as also on the slight cost of the repairs.

The CHAIRMAN said that the reduction of tariff by the Anglo-American Telegraph Company had not, he thought, been long enough in operation to affect—certainly they had not perceived its effect. The other remarks of Mr. Newton, he thought, conveyed a good suggestion, and they would consider it when they published their next sheet.

Mr. NEWTON observed that the object could be effected by using two sorts of types for the breaks of the respective companies.

Mr. GREENWOOD said that he had been a shareholder for some years, and he never remembered seeing such a satisfactory report as that laid before them on that occasion. He thought that the Company was in an exceedingly sound and safe position, and he quite endorsed the remarks of the chairman as to the advantage of having a large reserve fund, which would give a higher value to their shares. Looking at the present state of things—with an increasing revenue, being enabled to meet extraordinary charges for repairs, and after providing for the preference dividend, paying a dividend of 6 per cent., and carrying over to the reserve fund what was equal to another 5 per cent.—he thought they had done well; and in these circumstances it occurred to him whether it would not be advisable to try and get rid of the incubus of the preference shares. No doubt the Board had considered the question of how they could be got rid of. He thought it could be done somehow in this way:—That they should create £100,000 of share capital in £10 shares bearing a dividend of 6 per cent. per annum, and distribute those shares amongst holders of the present preference shares, which would give them precisely the same dividend they now received, and be a charge on the Company equal to what they now had to bear, but at the same time make the new shares redeemable by the Company and convertible at the option of the holders into ordinary shares. By that means he thought they would get all the shares converted into ordinary. He was a great advocate of having ordinary shares at all times, as then all could participate in any good which accrued to them, and, on the other hand, bear a part in any misfortune.

Mr. CHAPPELL thought that the shareholders had every reason to be thoroughly satisfied with the report. He contended, however, that they ought to receive 7 per cent. instead of 6, having regard to their increased revenue and encouraging prospects. They had earned after 10 per cent. to the preference shareholders something like 17 per cent. on the capital of the Company. He fully endorsed the addition as recommended to the reserve fund, holding that nothing was more advantageous than a good reserve. They would carry over 1½ per cent., and it was that with which he would like to deal. He did not intend to move any resolution on the subject, but suggested whether one per cent. more could not be paid. They would then carry over £316, instead of £1,116, as proposed. He thought that that amount would be sufficient to carry over, seeing that there was every prospect from the tone of the report, and from what they could judge of an increase of traffic. He believed also that the current six months was generally the more prolific half year.

Mr. GRIFFITH agreed with almost everything that had fallen from the previous speaker. The report was full of hope and promise for the future.

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He thought that Mr. Greenwood had started a very interesting question, whether, now that the Company was becoming so prosperous, it would not be well to consider the advisability of redeeming the preference shares. He, however, hardly took so strong a view of that matter as Mr. Greenwood, but, on the other hand, it was a source of not exactly complaint, but it excited a little ill-feeling among the ordinary shareholders that the preference shareholders should receive so large a dividend. Such a feeling, however, was unfair, because the holders of the ordinary capital had had all the benefit which the preference capital gave them. As to an increase of dividend, he thought that much could be said in favour of Mr. Chappell's suggestion, on the ground of justice, equity, wisdom, and safety. The ordinary shareholders had borne the burden of the heat of the day, and he thought they should reap some of the fruits when prosperity dawned upon them. The directors had uncontrolled power as to adding to the reserve fund, but although they recommended a dividend the Company sanctioned it. He thought the directors might consider whether they could not distribute some of the amount which they recommended should be carried forward. It might be done with perfect safety, seeing that the income of the Company in the past half year had enabled the directors to put an additional sum of £3,500 to the reserve fund, and in addition they had spent nearly £4,000 on repairs. Surely caution was being carried to extreme if it were proposed to do more than that. They did not wish to touch the reserve fund, but merely the amount proposed to be carried forward. A further argument in favour of an increase of the dividend was the excellent report of the directors, in addition to which the chairman had told them that their business was still in a satisfactory position. He believed that their shares were at present below par, and that an increase of the dividend would place them at their just value.

Mr. HOOPER thought that the Board had exercised judgment and discretion in not recommending more than 6 per cent. on the present occasion. The directors had managed the Company's affairs exceedingly well for a great many years, and for the sake of one-half per cent. he thought it advisable not to question their better judgment. He wished, however, to ask whether, given no breaks, the directors proposed limiting the dividend to 6 per cent. till they got the reserve fund up to £50,000.

The CHAIRMAN, in reply, said the point raised by Mr. Greenwood had constantly occupied the attention of the Board—that very day they had been considering the matter. No doubt they would be greatly benefited if they could redeem the 10 per cent. stock, and he trusted it might be possible to do so at no very distant date. He regretted to say that the Board had no power, under the constitution of the Company, of buying those shares on behalf of the Company. They would remember that five years ago, when those preference shares were raised, the Company's affairs were in a very different position from what they were now. With very great reluctance the Board had to agree to terms for obtaining the capital, which they felt very hard at the time, and would press in future upon the Company in a very serious manner. At the same time they felt then, and still felt that there was a fair prospect of redeeming that stock in the only way in which he thought it was likely to be redeemed—by the enhanced value of the ordinary stock to such a point that the preference shareholders would be ready to take it in exchange. On that point, as it bore on the subject, he would state, in reply to Mr. Hooper, that the directors had no idea whatever of limiting the dividend to six per cent. until the sum of £50,000 was put by to the reserve fund. There was a sort of tacit understanding that the amount to be put to the reserve fund was not to exceed £5,000 in any half year; and supposing there to be no breaks in any part of the year, and the business to remain as at present—and they hoped it would be larger—they would have no difficulty in making a considerable advance on the present dividend. The question of dividend practically remained (as Mr. Griffith had said) with the shareholders, but the Board had advised what they considered to be the most prudent course for the present half year. It was, however, perfectly competent for the shareholders to declare another ½ or 1 per cent. He then put the motion for the adoption of the report and accounts, and it was carried unanimously.

Mr. GRIFFITH then proposed that the directors be requested, considering the prosperity of the Company, to declare a bonus of 1 per cent. for the half year.

Mr. STOKES seconded the motion, observing, however, that he should be sorry to move or second any resolution unless it met with the approval of the directors.

Mr. HOOPER moved what he intended as an amendment, but

The CHAIRMAN pointed out that it was a negative.

Mr. HOOPER said he would negative the resolution. It was all very well to say that they did not wish to differ from the directors, but such a resolution, he contended, did indicate a difference.

Mr. GREENWOOD said he should support the directors' recommendation. They only proposed to keep the money in the pockets of the Company for another six months, and it would not be lost.

Mr. NEWTON pointed out that the Cuba Company was the only telegraph company which paid 6 per cent., except the Submarine Telegraph Company (a report of whose meeting appears in another column), who had a special monopoly. He thought that the dividends should only be increased where there was the prospect of the increase being maintained. The shares in the market would stand far better with a settled than with a fluctuating dividend.

The CHAIRMAN then put the motion, observing that the Board would exert no influence on the question except voting as shareholders. Only four hands were held up in favour of the resolution, and, subsequently, a resolution was passed declaring dividends at the rate of 10 per cent. per annum on the preference shares, and at the rate of 6 per cent. per annum on the ordinary shares. Replying to a question, the chairman said about two-thirds of the preference shares were held by the ordinary shareholders, so that, after all, the question did not interest many outside the Company. That fact would make such an arrangement as Mr. Greenwood had suggested much easier.

Mr. STOKES then moved, and Mr. GRIFFITH seconded a vote of thanks to the chairman and directors, the latter gentleman observing that the motion as to a bonus was not intended to express dissent from the directors. It was only brought forward as a slight difference of opinion.

The CHAIRMAN, in reply, said they would take into consideration all that had been said before the next half-yearly meeting.

The proceedings then terminated.

SUBMARINE TELEGRAPH COMPANY.

The half-yearly general meeting of the proprietors of this Company was held at the City Terminus Hotel, Cannon-street, on the 17th inst., under the presidency of Sir James Carmichael, Bart., chairman of the company.

The SECRETARY (Mr. S. M. Clare) read the notice convening the meeting, and the report of the directors was taken as read. It stated, *inter alia*, that, comparing the accounts for the six months ending the 31st December last with those for the corresponding portion of 1878, there had been an increase in the receipts, while a small decrease had occurred in the cost of repairs to cables. The nett result of the business for the six months just passed showed a sum of £35,084 belonging to the Chartered Company, which enabled the directors to recommend a dividend at the rate of 18½ per cent. per annum, and to add £2,550 to the reserve fund. The directors had agreed upon terms with the managers of the Paris and New York Telegraph Company for placing a cable across the Channel, to land at Penzance, so as to establish another telegraphic route between England and America; and the Paris and New York Company were negotiating with the Postmaster General for the use of a land line from London to the coast, to be placed in connection with the cable. The general introduction of a word rate for European correspondence would be made on the 1st April next, which, no doubt, would cause some increase in the expenses of the Company; but, on the other hand, the directors anticipated a considerable augmentation in the number of messages. The statement of joint earnings for the half year showed that the amount received had been £61,312.

The CHAIRMAN said it really gave him sincere pleasure on that occasion of meeting them that he had not to preface the few remarks he had to make with the usual statement as to depression of trade and commerce, which he believed that the chairmen of companies had had to do for some years past. He believed that the turn in the tide had come, and that they might expect better times. At all events, the increase shown by their report and accounts of the last half year was a very sure indication of the improved state of commercial affairs in this country. Nothing proved that more than an increase of telegraphic business. With that increase, and with the increase of prosperity which they would have, he hoped, with a renewal of confidence in all branches of trade and industry in this country, they must of necessity largely participate. With regard to the report, they would see that their repairs to cables had been less onerous than usual. He believed that that was to be attributed simply to the fact that they had been so far fortunate in that fewer accidents had occurred, and, of course, with an absence of accidents there had been a smaller amount of new cable required. He thought they might congratulate themselves on that fact, but, of course, next year they might have a large amount to expend, since it was not a thing they could rely on as a matter of course. There was one subject he had to say a few words on. In the last three months they had ceased to publish the monthly statement of their traffic, which they had usually done. There had been a slight disagreement between themselves and the Post Office as to a charge of certain rates on the Continent. Until that was settled they thought it might only be illusory to them to publish the statement, and they therefore stopped the publication. They must remember that the balance sheet laid before them, as well as the dividend they recommended, was entirely exclusive of any differences whatever between themselves and the Post Office. He need hardly remark that their relations with the Post Office had always been of a most friendly nature, and the present was only a little question of account, which he had no doubt would be settled in an amicable manner. He drew attention to that because when he put the motion for their approval it would stand as follows:—"That the report and accounts now read, with the addition of the words 'exclusive of a sum in suspense claimed from the Post Office,' following the words 'to amount received during the half year,' in the statement of joint earnings, be received and adopted." In their balance sheet they had carried this sum to suspense account. They had debited the Postmaster General with that. He had no further remarks to make on the report and accounts. Their new building was progressing in the most satisfactory manner. There had been some delay in the construction of it consequent on the very severe weather and the dreadful fogs, but he hoped that in two or three months the building would be completed, and he trusted that in the course of the summer they would occupy it. Their cables were all in good working order, except a short line from Salcombe to Brest, which was now under repair. It was worked by the Anglo-American Telegraph Company. The progress alluded to in their receipts had continued, he was happy to say. Their traffic was most satisfactory, and they had every reason to look forward to the current half year being quite as good as last. He then put the resolution, as above.

Alderman Sir T. DAKIN (a shareholder) having formally seconded the motion,

Mr. BARLEE referred to the statement in the report respecting a new cable, and wished to know at whose expense it would be put down, and from what part of France it was to be laid.

The CHAIRMAN, in reply, said that the expense of the new cable would be entirely borne by the Paris and New York Telegraph Company. It would be laid from a point near Brest to a point near Penzance. The cable was the property of the Submarine Telegraph Company, but the other company would lay the cable under the supervision of this Company, whose engineer would be on board the ship. The cable would be laid by arrangement with the Submarine Company, by which they would receive from the other company a considerable sum. He should think that the distance would be about ninety miles. In reply to other questions and remarks, the nature of which is indicated in the reply, he stated that Salcombe was in Devonshire. That line was, as he had said, worked by the Anglo-American Telegraph Company under a lease to them, but it belonged to this Company. The new cable would belong to this Company, and be leased to the French company, who, of course, would receive the revenue and pay this Company the amount of the lease. The Government were partners with the Company, and brought into the partnership certain cables. The Company worked all the cables, and divided the profits. The present agreement was under Act of Parliament, and would expire in 1889. They would rather not go into the question of the amount carried to the suspense account. It was a matter between themselves and the Post Office, and he was sure that the shareholders could leave the matter in the hands

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of the Board. They would receive the dividend recommended quite independent of that amount. He then put the resolution, and it was carried unanimously. Continuing, he moved "That, in accordance with the recommendation of the directors, a dividend for the half year ending 31st December, 1879, at the rate of 18½ per cent. per annum, less income-tax, on the capital of the Company, be declared and become payable on and after the 1st of March next."

Mr. WILSON (a shareholder) seconded the motion, and it was carried unanimously.

On the motion of Alderman Sir T. DAKIN a vote of thanks was passed to the chairman and directors.

The CHAIRMAN, in acknowledging the compliment, expressed a hope that next half year they would be able to lay before the shareholders an equally satisfactory report.

The proceedings then terminated.

THE DIRECT UNITED STATES CABLE COMPANY.

Report of the directors for the six months ending 31st December, 1879, to be presented at the fifth ordinary general meeting of the Company, to be held at the City Terminus Hotel, Cannon-street, on Friday, Feb. 27th, at 12 o'clock. The usual statements of account for the half-year ending 31st December, 1879, are submitted herewith. For the half-year the revenue, after deducting out payments, amounted to £120,445 8s. 6d. against £89,943 14s. 8d. (after similar deductions) for the corresponding half-year of 1878, being a difference of £30,501 13s. 10d. in favour of the half-year under review. The working and other expenses, including interest on debentures, amounted to £25,001 3s. 6d., leaving a balance of £95,444 5s. as the net profit of the half-year, making with £2,345 1s. 5d. brought forward from the previous half-year, a total balance of £97,789 6s. 5d. For the corresponding half-year of 1878, the working expenses and other payments amounted to £21,748 9s. 11d. Interim dividends of 1¼ per cent. each for the quarters ending 30th September and 31st December, 1879, together amounting to £30,355, have been declared and paid. The directors have, after mature deliberation, considered it expedient in the permanent interests of the Company, to add a further substantial amount to the reserve fund, and have accordingly placed to the account of that fund a sum of £48,942 2s. 9d., thereby increasing it to £150,000. The sums of £1,900 on preliminary, liquidation, and arbitration account, and £914 7s. 1d., the cost of removing spare cable, together amounting to £2,814 7s. 1d., have been written off, and £15,677 16s. 7d., the balance of the £97,789 6s. 5d. mentioned above, is carried forward. The cables are now, and have been during the half year, in good working order without any interruption. The £100,000 debenture loan has been placed, and the proceeds have been applied in completing the measures necessary on taking up the 3,813 shares of the dissentients, and paying off the £17,300 seven per cent. debentures of the old Company. The residue puts the capital account of the company on a thoroughly satisfactory footing.

NEW PATENTS, 1880.

158. APPARATUS AND ARRANGEMENTS FOR TELEPHONIC AND MICROPHONIC PURPOSES, *L. J. Crossley.—Jan.* 14.

203. IMPROVED APPARATUS FOR DEVELOPING THE ELECTRIC LIGHT, *J. Clark.—Jan.* 16.

ABSTRACT OF PATENTS.

1959. ELECTRIC LAMPS, *J. Hopkinson.—Dated 16th May*, 1879. 4*d*.

Points of the main circuit are connected on opposite sides of the electric arc by a firm wire forming a solenoid or electro-magnet. The current in this fine wire is necessarily proportional to the difference of electric potential on the two sides of the lamp.

1969. ELECTRIC LIGHT APPARATUS OR LAMPS, *A. Longsdon.—Dated 16th May*, 1879. 6*d*.

The core of an electro-magnet is connected to a lever connected to the lower carbon holder, and also by a rod to a clamping device for the upper carbon. A spring is connected with the lever so as to counteract the force of the magnet.

TRAFFIC RECEIPTS FOR JANUARY, 1880.

COMPANIES.	Jan. 1880.	Jan. 1879.	Increse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	3,200 estd.	3,043	157	—
Direct Spanish Telegraph Company	—	—	—	—
Direct United States Telegraph Company	—	—	—	—
Eastern Telegraph Company	48,887	39,226	9,661	—
Eastern Extension Telegraph Company	28,009	24,695	3,314	—
Great Northern Telegraph Company	17,280	13,876	3,404	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—

TELEGRAPH SHARE LIST.

COMPANIES.	CLOSING PRICES FEB. 18.		BUSINESS DONE WEEK ENDING FEB. 18. Highest.	Lowest.
Anglo-American Ordinary ..... ex div.	60½,	1	62½	60½
Do. "B"	88¾,	9¼	89¼	88½
Do. "A" ..... ex div.	33,	½	36½	33
Brazilian	7 15-16,	8 1-16	8 1-16	8
Cuba	9,	⅛	9⅛	9⅛
Do. Ten per Cent. Preference	16½,	17	—	—
Direct Spanish	2,	⅛	—	—
Do. Ten per Cent. Preference	11¾,	⅞	11¾	11½
Direct United States	11½,	⅝	11⅝	11⅝
Eastern	9,	⅛	9 3-16	9
Do. Six per Cent. Debenture	103,	6	—	—
Do. Five per Cent. do.	101,	3	102½	101
Do. Six per Cent. Preference	12,	⅛	12⅛	—
Eastern Extension	9 1-16,	3-16	9 3-16	9 1-16
Do. Six per Cent. Deb.	104,	7	—	—
German Union	8¾,	9	9¼	8⅞
Globe Telegraph and Trust	5⅝,	¾	5 13-16	5 11-16
Do. Six per Cent. Preference	11⅜,	⅛	11⅝	11⅜
Great Northern	9½,	⅓	9½	9⅝
Indo-European	24,	6	25⅛	25
Mediterranean Extension	3,	½	—	—
Do. Eight per Cent. Preference	10¾,	11¼	11	11
Reuter's	10⅛,	11⅛	10⅞	10½
Submarine	235,	45	245	240
West India and Panama	2,	⅛	2⅛	2
Do. Six per Cent. Preference	7⅞,	8⅛	8 7-16	7 15-16
Western and Brazilian	7 9-16,	11-16	8 1-16	7⅞
West. Union Seven per Ct. 1st Mt.	120,	5	—	—
Do. Six per Cent. Sterling	105,	7	107	107

ADDRESSES.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

PETER BROTHERHOOD, Engineer, 56 and 53, COMPTON-STREET, GOSWELL-ROAD, E.C.
Specialities—Patent 3-Cylinder Engines (Silver Medal, Paris), as used by Siemens, Gramme, and Wilde for driving Electric Machines.

RANSOMES, SIMS, and HEAD, Orwell Works, IPSWICH.
Specialities—Portable and Stationary Engines, fitted with patent governors, as tried in the electric lighting experiments on the Thames Embankment.

ABBOTT and Co., NEWARK-ON-TRENT.
Specialities—The "Standard Size" Vertical Cross Tube Boilers. Illustrated catalogue, giving every detail of a variety of Boilers, 2s. 6d., post free.

CARBON ELECTRODES COMPANY. Works: 39, COMMERCIAL-ROAD, EAST.
Specialities—Carbon Rods of all sizes for Electric Lighting. Also, Plates and all other Moulded Carbon Goods. List of prices on application.

M. THEILER & SONS, Telegraph Instrument Manu-facturers, 86, CANONBURY-ROAD, N. Works: ALWYNE-LANE, N.
Specialities—Morses, Polarised Relays, Saunders' Curb Keys, Type Printers, Recording Sounders, Duplex Apparatus (Theiler's Patent).

HOOPER'S TELEGRAPH and INDIA RUBBER WORKS, MITCHAM and MILLWALL DOCKS.
Contractors for the Manufacture and Laying of Submarine Telegraph and Torpedo Cables. Manufacturers of Hooper's celebrated Insulated Core. Printed reports on application. Offices: 31, LOMBARD STREET, LONDON, E.C.

THE BRITISH ELECTRIC LIGHT COMPANY (Limited), 41, PARLIAMENT-STREET, WESTMINSTER, and 17, WATER-STREET, LIVERPOOL.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

ESTABLISHED 1851.

BIRKBECK BANK.—Current Accounts opened according to the usual practice of other Bankers, and Interest allowed on the minimum monthly balances. No commission charged for keeping Accounts.
The Bank also receives money on Deposit at Three and a Half per Cent. Interest, repayable on demand.
The Bank undertakes for its Customers, free of charge, the custody of Deeds, Writings, and other Securities and Valuables; the collection of Bills of Exchange, Dividends, and Coupons; and the purchase and sale of Stocks and Shares.
Letters of Credit and Circular Notes issued for all parts of Europe and elsewhere.
A Pamphlet, with full particulars, on application.
FRANCIS RAVENSCROFT, Manager.
Southampton-buildings, Chancery-lane.

The Birkbeck Building Society's Annual Receipts exceed Four Millions.

HOW TO PURCHASE A HOUSE FOR TWO GUINEAS PER MONTH, with immediate Possession and no Rent to pay. Apply at the Office of the BIRKBECK BUILDING SOCIETY.

HOW TO PURCHASE A PLOT OF LAND FOR FIVE SHILLINGS PER MONTH, with immediate possession, either for Building or Gardening purposes. Apply at the Office of the BIRKBECK FREEHOLD LAND SOCIETY.
A Pamphlet, with full particulars, on application.
FRANCIS RAVENSCROFT, Manager.
Southampton-buildings, Chancery-lane.

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WEATHER TELEGRAPHY.—It has been decided to adopt a complete system of weather telegraphy for the Australian colonies.

KÖNIGSBERG.—The annual receipts at the telegraph office at this town are over 300,000 marks. There are about fifty instruments in work.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY. The next ordinary meeting will be held at the Cannon-street Hotel on the 2nd March.

ELECTRICITY IN THE HOUSE.—Dr. L. Playfair has, we understand, adopted the Jablochkoff system for partially lighting his town residence.

AMPERE.—The archives of the French Academy, which contain many precious documents relative to the illustrious Ampère, are to be revised by M. Maindron.

RISE IN TELEGRAPH WIRE.—The price of best drawn telegraph wire in long lengths has gone up 30s. per ton, and we hear on good authority that it is likely still to rise.

MR. CYRUS FIELD.—Mr. Field, after visiting the south of France and Algiers for the benefit of his health, has now arrived in London, prior to embarking for the United States.

MR. CROOKES.—An extraordinary prize of 3,000 francs has been awarded by the French *Academié des Sciences* to Mr. W. Crookes, F.R.S., in recognition of his recent electrical researches in Molecular Physics and Radiant Matter.

EDISON'S ELECTRIC LIGHT.—We have received from several sources information upon this subject, all of which confirms the opinion we originally expressed on the question, viz., that Mr. Edison has not made one single step in advance.

FIRE TELEGRAPHS FOR LONDON.—The City Commissioners of Sewers have at length determined to try the system of telegraphic fire alarm boxes in the streets of the City. At the recent meeting of that corporation a list was given of the points at which the experiments would be tried.

AN APOLOGY.—We are sorry to find that, in our issue for January 17, we discredited our contemporary, *Iron*, with a paragraph describing the New French Cable. The paragraph should have been quoted as from *The Universal Engineer* and merited a much stronger criticism than that which we gave.

BAVARIA.—The corrected returns for 1878 show a loss on the working of the telegraphs. Thus :—

	Rmk.	pf.
Telegraphs—Receipts	1,025,289	00
„ Expenditure	1,063,256	00

showing the loss be 37,967 rmk.

THE ELECTRIC LIGHT AT BARCELONA. — The Electric Light Company (promoted by D. Francisco Taulina) deposited on February 19th at the Barcelona Bank, 50,000 pesetas, the sum being 2 per cent. of the capital subscribed. It is understood the Company has the intention of working Messrs. Molera and Cebrian's invention.

TELEPHONE APPARATUS FROM AMERICA.—The International Telephone Company has adopted the switch-board for exchanges, invented by E. T. Gilliland, for use in Europe, and on February 1st switch-boards were shipped for use in London and Berlin. With these switch-boards one operator can work fifty or sixty wires without leaving his seat.

TELEPHONE EXCHANGE FOR GLOUCESTER.—A meeting was held last week to discuss the question of establishing a telephonic exchange at Gloucester. The sum mentioned as necessary to connect Gloucester with Sharpness, viz., £7 per mile of wire and £10 per instrument, or a total of from £100 to £120 per annum, seems to us exorbitant, and out of all proportion to the benefit to be obtained.

AN IMPRACTICABLE SCHEME.—The *Druplex Polytechnic Journal* notices a proposal which has seriously been put forward for heating steam boilers by means of platinum rendered incandescent by the passage of a current. We think that our contemporary's estimate of the cost of so doing, viz: a cost thirty times greater than that of heating directly by coal, is certainly not exaggerated if voltaic batteries are to be used for the purpose. In any case the scheme deserves mention only by way of warning to a certain class of "inventors."

PORTUGAL.—This country has expended during a period of twenty-five years over £640,000 on the telegraphs, and up to the present time there is but slight appearance of their bringing the State any return for the outlay. In 1867 the expenditure exceeded the receipts by 127 per cent. It must, however, be supposed that in this expenditure was included capital sunk in construction and plant, and not simply working expenses. In 1877 the loss was only 20 per cent. on the receipts, which were £32,000 against an expenditure of £38,600, and the balance is being gradually attained.

ILLUMINATION BY ELECTRO-PHOSPHORESCENCE.—A French paper states that Dr. Phipson has proposed a new solution of the question relative to a cheap means of illumination for domestic purposes. He has succeeded in augmenting considerably, by means of a comparatively weak electric current, the phosphorescence of certain substances influenced by the solar rays. He encloses within a Geissler tube a phosphorescent substance, such as the sulphide of barium, and causes the tube to be traversed by a constant current of a certain intensity. By this means, it is stated, a uniform and agreeable light may be obtained at a less cost than by means of gas.

REPRODUCTION OF DRAWINGS, &C., BY MEANS OF THE ELECTRIC LIGHT.—The Marion process, by which a drawing is reproduced in white lines upon a blue ground, when the original is placed over a sheet of sensitisid paper and exposed to the solar rays, is well known. Unfortunately, the solar rays even on the shores of the Mediterranean cannot always be depended upon; and, to obviate this objection, the Paris-Lyon-Mediterranean Railway Company has applied the electric light for the purpose in view. Two Gramme machines of the workshop pattern and two Serrin lamps are thus employed; and the reproduction is found to be perfect after an exposure of twenty minutes.

SPARKING OF ELECTRIC LAMPS.—Now that electric lamps have been shown to give off a considerable quantity of heat, and that even the well-closed Siemens lamps, now being tried in the British Museum on account of their superior safety as compared with gas in the matter of fire, have been found to throw off dangerous red-hot sparks of charcoal, the importance of using the very finest and most homogeneous carbons in electric lamps is more and more patent. If incandescent lamps cannot be found to answer on the score of cost and durability, there is ample room for improvement on a more hopeful line, namely, the perfection of the arc by means of the carbons consumed in it.

ARTIFICIAL PRODUCTION OF THE DIAMOND.—This important chemical feat has been accomplished at last, if we are to believe Professor Nevile Story-Maskelyne. If Mr. Mactear, chemist of St. Rollox, Glasgow, failed, Mr. Ballantine Hannay, chemist of Sword-street, Glasgow, has succeeded. The small

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crystals which are the first fruits of his process have all the appearance of the diamond, and stand all its characteristic tests. They are inert in polarised light, they score sapphire deeply and with ease, and, finally, they glow when heated in platinum foil, and gradually disappear. The process so important to the arts and to diamond owners will shortly be communicated to the Royal Society.

Electric Fluorescence.—It has been found by M. Wiedemann that nearly all platino-cyanide double salts show fluorescence under the electric discharge; but so long as they are undecomposed no double fluorescence is observed. When platino-barium cyanide had been traversed by a single discharge, the strong fluoresent light showed no dichroism, but after a series of discharges it appeared. It also occurred when crystals of platino-varium cyanide or other platino-cyanide double salts were left a long time *in vacuo* (without electric discharge), whereby they lost water; and the more rapid appearance or dichroism under the electric discharge is attributed by him to the heating of the crystals.

Long Range Telephoning.—An important experiment with the telephone, says the *Scientific American*, was made on January 25, between the Union Pacific Transfer, on the east side of the Missouri River, and the American Union office, at St. Louis, a distance of 410 miles. The experiment previously made between Omaha and St. Louis had been unsatisfactory. Superintendent Dickey, of the telegraph lines, conducted the experiment at the western end of the line, and Mr. Benedict, of the American Union Company, at the other. Two Calland cells were used at Omaha, and five at St. Louis. An ordinary conversation was carried on with ease, in spite of heavy induction at the St. Louis end.

India rubber.—We take the following from a Blue Book issued this month :—"This chief article of export continues increasing annually, as new fields are constantly being opened when the old districts fail somewhat in their yield; so that, although there are no fresh plantations or the old trees cared for, there is no reason to surmise that the crop will not yearly increase in proportion to the increase of population, as there are yet vast rubber districts still untouched. It is, however, to be lamented that this valuable article of commerce is so easily obtained, as it causes the natives to be indolent and careless, bestowing slight attention to the cultivation of other products which are of paramount necessity, such as coffee, sugar, rice, farinha de mandioca, &c., all of which are now imported." This refers to Para.

The Princess's Theatre.—It would be interesting to make a study of the effect the progress of electrical science will have upon future plays, and we may take an opportunity of speaking at length on the question. Meanwhile, we notice that Mr. Dion Boucicault's *Streets of London* has been revived for a short time at the Princess's. In this play realism abounds, and it seems to us that in any similar play, or even scene, the introduction of the electric light into our towns will be considered. The time will shortly come when suicides from bridges, water rats in the river, incendiaries, and such like things, must be carried on under a brilliant light, or in fear of automatic alarums. If we had to criticise the piece at the theatre above mentioned, we should say that it was well written, well acted, and well put on the stage.

A Strange Visitor from Another World.—As David Torrence was digging near his home on the Steep Rock road, near Norwalk, Conn., he found what he supposed, from its worn, corrugated appearance, to be an old six-pound cannon ball, but upon bringing it into town it was decided by a gentleman familiar with these things to be a genuine aerolite, composed largely of magnetic iron and of probable recent origin. When Mr. John Hoyt, operator for the new American Union Telegraph Company, in Mr. Stanley's store, at the suggestion of a bystander, attached the wires of his battery to it so as to form a circuit it instantly threw out a shower of sparks, and gave forth a loud humming sound similar to that heard in a planing mill. The aerolite, for such it undoubtedly is, is now on exhibition in Norwalk, and will be sent to the Smithsonian Institute at Washington.—*New York paper.*

The Indian and the Telephone.—An amusing application of the wonders of the telephone as an assistant detective of crime is related in a Californian paper. Several horses were recently stolen in the neighbourhood of Julian, and suspicion fell upon a certain Indian as the thief. Some one having introduced a telephone up there, the same was being exhibited, when it occurred to the owner of the stolen horses to get the Indian to come in and hear the "Great Spirit" talk. The Indian took one of the cups, and was thrilled with astonishment at being apparently so near the Great Keeper of the happy hunting grounds. After some little time spent in wonderment, the Indian was solemnly commanded by the Great Spirit to "give up those stolen horses!" Dropping the cup as if he had been shot, the Indian immediately confessed to having stolen the horses, and tremblingly promised if his life was spared he would restore the "caballos" at once, and he did so.

Telephone Exchange at Madrid and Barcelona.—Mr. Emilio Rotondo Nicolau, manager of an American company, entitled "The Spanish American Telephone Company," has been authorised by a royal order to establish a telephone exchange (on the same scale as those of New York, Philadelphia, Boston, &c.) at Madrid. The above Señor Nicolau has also solicited permission of the corporation of Barcelona to lay substerranean and aërial lines, necessary for organising a similar service in this town. The Spanish American Telephone Company have the intention of bringing the Government offices, barracks, fire stations, &c., in communication with their central office, and also of placing telephone boxes in the principal streets and quarters of Barcelona, the keys of these boxes to be in charge of the police authorities for the purpose of calls in cases of fire, &c. The Company finally offers to pay a tax to the corporation upon all the instruments used by subscribers.

Proof of Death.—Those timid beings who are haunted by apprehensions of being buried alive, and who make testamentary provisions against such a contingency, may now take courage, for science has supplied an infallible means of determining whether or not the vital spark has quitted the mortal frame. Electricity enables us to distinguish with absolute certainty between life and death; for two or three hours after the stoppage of the heart, the whole of the muscles of the body have completely lost their electric excitability. When stimulated by electricity they no longer contract. If, then, when Faradism is applied to the muscles of the limbs and trunk, say five or six hours after supposed death, there be no contractile response, it may be certified with certainty that death has occurred, for no faint, nor trance, nor coma, however deep, can prevent the manifestation of electric muscular contractility. Here there is no possibility of mistake, as there certainly was when the old tests were employed.—*Medical Press and Circular.*

Telegraphs to Russia.—Mr. H. G. Erichsen, on behalf of the Great Northern Telegraph Company, has written the following letter, denying the accuracy of the statement which was given in the *Standard* as to the interruption to

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the Danish cable, and giving the true reason for the delay in the transmission of telegrams. He says:—"Sir: I observe in your impression of to-day that your St. Petersburg correspondent informs you that interruption of the Danish cable since the 5th (17th, New Style, I presume) has caused delay in the transmission. I therefore beg to inform you that neither the company's Danish-Russian nor their Danish-English cables are, or have been, interrupted, but that, owing to heavy snowstorms, the Danish Government landlines have been down all over the country. The company had, therefore, to transmit all the Russian messages by its Swedish route, whence a delay arose. The Danish landlines are now announced to be in order, and messages are received in good time from Russia. As your report is apt to mislead our shareholders, I will deem it a favour if you will insert a short correction."

An Improved Submarine Telegraphic Cable.—Messrs. Blondot and Bourdin suggest a telegraphic cable composed of a single copper conductor covered with several insulating coatings. The first of these (that in contact with the conductor) is of gutta percha, the second is of caoutchouc, the third of gutta percha, the fourth of caoutchouc, and the fifth of gutta percha mineralised by a mercurial salt. The cable is to be further surrounded by a covering of tarred hemp. It is stated that the density of this cable is lower than 1·7, except at the ends, which have a metallic covering like ordinary cables. The soldering or uniting of the conductor is effected as follows:—The two ends to be united are bevelled and soldered with silver solder; a piece of copper tube without solder covers the bevels, and extends about half an inch beyond them. A little silver solder is run into the tube for its whole length, so as to compensate for the weakness caused by the non-continuity of the conductor. The covering tube is thinned externally at its ends in order to avoid creating a point of least resistance to its flexion, and to facilitate the laying of the insulating covering.

The New German Electrical Society.—This society, which takes the name of the *Electrotechnische Verein*, held its first meeting on Dec. 20, 1879. It is composed (1) of ordinary members, who pay an annual subscription of twenty marks (£1) if they reside in Berlin, and only twelve marks if they live elsewhere, (2) of corresponding members who must reside at a distance from Berlin, and (3) of honorary members who in general are foreigners distinguished in electrical science. At the head of the society is a president of honour (ehrenpräsident) charged with the duty of representing it in its external relations. This office has been accepted by Dr. Stephan, Postmaster-General for the Empire. The administration is confided to a committee composed of the effective president (Vorsitzender), the vice-president, the two secretaries, a syndicate, a cashier, and a treasurer, all nominated by a general assembly of the members. The society meets on the fourth Tuesday of each month from from October to May inclusive. The business of the society consists in communications, abstracts, and reports of members or correspondents, or new inventions, discoveries, and experiments in the whole domain of applied electricity, accounts of the meetings, and the publication of a journal.

Nickel Plating at Stockton-on-Tees.—Describing the Bishopton-lane Works of the Plating Company (Limited), a contemporary says:—"On approaching the works we were surprised to find the arrivals comprised marine engine fittings from prominent firms, locomotive mounts, starting and reversing gear, connecting rods, valves, handrails, and other exposed parts of engines and engine-fittings. Household goods in great variety are here nickeled; chains for pulley-blocks, wire and wire-ropes, weighing machine apparatus and weights, valve springs, steam cylinders, and steam condenser tubes were also undergoing the process. A special feature introduced at these works is the treatment of moulds from ironfounders and brassfounders. It has been discovered that by nickeling these a smooth surface is presented for moulding from, and that castings so made are without the jagged uneven appearance which many possess—indeed, a perfect facsimile of the original is produced. Besides this great advantage the mould is effectually preserved from rust and depreciation." Weston's dynamo machine, worked by a 10 horse-power engine, is here employed to generate the current. This company, in 1868, purchased the patent for nickel plating of Mr. P. Adams, of Philadelphia. It is found that a coating of nickel possesses about ten times the durability of a coating of silver of equal thickness. At these works, all iron or brass articles receive a coating of copper from a cyanide bath before being immersed in the sulphate of nickel solution, as it is found that better adherence is thus obtained.

Cable Captures.—Mr. Moginie has called upon me, says Frank Buckland, the celebrated naturalist, in *Land and Water*, with a lovely specimen of a sea snake which he wanted properly mounted in a bottle for the board room of the Eastern Extension Telegraph Company. One of the cables belonging to this company was being raised from the bottom of the sea, I believe in the Indian Ocean. When the cable came to the surface the snake in question was found coiled tightly round the telegraph cable. Luckily it was killed before it could do any mischief, as these sea-snakes are excessively poisonous. Mr. Moginie's snake is about a yard long, and the general colour of it is white, and it is most beautifully marked on the back with black, or rather dark chocolate, patterns. The tail is, as in all sea snakes, quite flattened, like the end of an oar. This, of course, gives the animal great power of swimming. My friend, Dr. Day, luckily came in just as I was consulting Sir Joseph Fayrer's magnificent illustrated work on the "Venomous Snakes of the Indian Peninsula," and I am now enabled to give the following account of it by Dr. Day:—"The example of sea snake (*Pelamis bicolor*) which you showed me as having been killed by a deep sea telegraph wire in the Indian Ocean, is a species having a very wide geographical range. I have taken an example in Scinde, another in Orissa, while it is reported to extend throughout the subtropical and tropical portions of the Indian Ocean. I have only met with a few examples, and do not look upon it as nearly so common as the blue-banded *enhydrina*. All these sea snakes, I need scarcely observe, are exceedingly venomous. This instance recalls to my mind a circumstance which occurred off the coast of Belochistan, near the Persian Gulf, in 1871, when the telegraph cable was ruptured. A few days subsequently the dead body of a whale was discovered on the sea beach, and I think the end of the cable was found wound round the animal's tail just in front of the tail fin. It appeared to me that the accident must have occurred somewhat in the following manner, premising that (as all know) the tail fin of a whale is placed transversely to the body, and not as in a fish:—If the telegraph wire passed from one rock to another, or from an elevated spot to the bottom of the sea, it would not be difficult to imagine that a whale swimming past might very easily become entangled. Should its transverse tail have hitched over the wire the animal would become frantic, and rolling itself round and round it might burst the wire in two, but still be held fast—due to telegraph wire encircling its tail just below the origin of the fin."

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LITERATURE.

Torpedoes and Torpedo Warfare: Containing a complete and concise account of the rise and progress of submarine warfare; also a detailed description of all matters appertaining thereto, including the latest improvements. By C. W. SLEEMAN, Esq., late lieutenant R.N., and late Commander Imperial Ottoman Navy. [Portsmouth: Griffin and Co. London agents: Simpkin, Marshall and Co. 1880.]

No one can doubt that torpedoes will play an important part in any future war between belligerents having coasts to defend and enemies' ships to attack, and the study of the subject by the officers of our Royal Engineers and Royal Navy is of the greatest national importance. How far it is expedient to lay before the public all that is being stored up by our two great torpedo departments is another question. The work taught in the torpedo school on board H.M.S. Vernon to officers and men is generally supposed to be kept as much as possible from publication. As regards this secresy, there is something to be said both for and against. By keeping everything as secret as possible, we secure to the nation the full benefit of any improvements made by the departments on which money is expended for the perfection of this species of warfare; but it must not be forgotten that by this secresy, supposing it to be effective, civil engineers, electricians, and chemists are prevented from knowing what is the present state of the subject in the Army and Navy. All chance of any invention on this subject is therefore cut off from these classes, from which invention and novelty are quite as likely to proceed as from the officers of the Army and Navy. We, in fact, pit the brains and energy of our naval and military officers only against those of the officials of all foreign governments; but we are supposed to secure them at any rate fair play as regards their improvements not being handed over to their competitors directly they are made. The question arises which is the most advantageous—to sacrifice all chance of improvement and invention by outsiders to the protection of official invention, or to run a race of invention between the general English public and foreign officials, at the expense of publicity on our side? It is hard to say which would be the most advantageous to the nation. But the Government is not consistent in these matters, and as they show everything to foreign officials out of international courtesy, there seems very little reason why publication should not be given to many matters which are kept from the English public though shown to foreigners. Indeed, it has been the complaint even of English officers of the Army and Navy that it is much more difficult for them to obtain information of experiments going on than for foreign officials to do so. We need scarcely fear, therefore, that Mr. Sleeman's book will injure our national interests much, even if it contained more than it really does on the subject. At the same time, when a gentleman who has been a lieutenant in Her Majesty's Service publishes such a work, containing in places allusions to "service" materials which look like passages from official books, it would perhaps have been better taste if some official sanction had been shown on the title-page. The description of the Whitehead torpedo sounds uncommonly like quotations from some brief official instruction how to use it. There seems, however, very little reason for secresy on this subject, since, although the Government paid £17,500 for the secret, it is also possessed by every other Government of importance, and, consequently, there is no body left to keep it secret from that could do any good or harm with the knowledge. Indeed, the secresy was evidently more for Mr. Whitehead's benefit than our Government's. Mr. Whitehead's tactics were charming. He sells and binds to secresy in order to repeat the operation with all the Governments in Europe. Now, had our Government paid a price to obtain the exclusive right to the knowledge, and *bound Mr Whitehead to secresy*, there would have been some sense in the transaction on our part, even if £100,000 had been paid for it.

Mr. Sleeman gives a very interesting sketch of the history of torpedoes, and shows that something of the sort was used as early as 1585 at the siege of Antwerp. To Captain Bushnell, of Connecticut, in 1775, Mr. Sleeman gives the credit of first firing gunpowder under water, and of thus being the father of torpedoes. He was followed by Fulton, an American engineer, who advanced the subject considerably. Then came Colt, an American, who blew a ship up under way in 1844, and here our author's historical notes at the commencement of the work end, and the chapter passes rather abruptly on to reflections. Our knowledge is still very theoretical on this subject, although later on in the work the author gives some very careful descriptions of the attacks by the Russians on the Turks during the late war, in which there was more failure than success, but still some experience was gained. Mr. Sleeman points out that the moral effect of torpedoes in defence is very great. During the Franco-German war "a German port was entirely defended by dummy mines, the burgomaster of that place having been unable to obtain men to place the active mechanical mines in position owing to the numerous and serious accidents that had previously occurred in other German ports at the commencement of the war in mooring the latter (mechanical) kind of submarine mine.

"The effect, so far as keeping the French fleet at a distance was concerned, was precisely the same as though active, instead of dummy mines, had been employed, thus still furthur proving the vast moral power possessed by torpedoes."

We have ourselves heard that a large number of the torpedo corps of the Germans were killed by accidents. This would, of course, be with the mechanical torpedoes, which the author points out as being so dangerous. It appears there is much room for invention here, for our author says of mechanical mines, "several ingenious methods have of late been devised for the purpose of obviating one of the principal defects common to all kinds of mechanical submarine mines, viz., the great danger attendant on the mooring of such mines, but as yet no really practical mode of rendering mechanical mines safe after they have once been moored and put in action has been discovered." Indeed, besides the difficulty of taking a mechanical mine up when once placed, they must be extremely dangerous to handle and transport at all after they are once charged.

The electrical mines, on the contrary, with ordinary precautions as regards the battery connections, must be absolute safety in comparison. They have been much simplified by the platinum fuse and simplification of the circuit breaker.

During the Crimean war, the Russians used torpedoes for defensive purposes, but with charges too small to be effective. The Confederates during the American war did not make this mistake, but as they did not understand the electrical requirements only one Federal ship was destroyed, according to Mr. Sleeman, though here our author is wrong, for, according to another work, several gunboats were sunk by torpedoes.

The work describes in detail the electrical mines now generally employed, the fuses, cables, joints, &c. The system of defence by electrical mines fired by keys at two stations where the ship comes on certain cross bearings observed through telescopes with cross wires from these stations is described, and the well-known shutter apparatus for showing which mine is struck, &c., is described and illustrated. Testing instruments are described, and some rules given for testing. We cannot say that those given are very good, and if they are a sample of what are used in the "service," the service certainly requires a little help from the outside world of electricians.

The Harvey towing torpedo is described. Lay's locomotive torpedo is very fully described, but the description of the Whitehead is meagre, and the illustration of no good whatever, as it is only an external view. It was pretty well known by persons outside the secret that the maintaining the torpedo at a certain depth was accomplished by means of the horizontal rudder being actuated by the pressure of the water on a diaphragm connected to the rudder by rods, and the present book publishes the further information that the pressure of the water on the diaphgram is counterbalanced by a spring which can be so adjusted to balance a certain depth of water, and thus maintain the torpedo at a certain depth, but no drawings are given of the details.

Torpedo boats are described, and Harvey's towing torpedo and various other torpedoes are described, but we are astonished to find no description given of the system of countermining which our naval torpedo school in the Vernon is constantly attempting to perfect.

The duty of the Royal Engineers is to defend our harbours, and one of the principal duties of our Navy as regards torpedo warfare is to be able to clear a passage through the torpedo defences of an enemy's port. To effect this, a submarine cable, say a mile long, and having branches from it at say some every sixteenth of a mile, with torpedoes attached to them, is disposed in a man-of-war's launch, so that the whole arrangement can be paid out, and the torpedoes dropped automatically in succession along the channel to be cleared. A boat is moored at some point outside the line of defence. On board this boat, called "the firing boat," the end of the torpedo cable is placed. This boat has also a large reel on which is placed a mile of two gutta percha covered wires fastened together, with small floats of cork attached at intervals, sufficient to float it. The outer end of this double line is on board the pinnace; and by suitable and ingenious arrangements one of these wires enables the party in the firing boat to steer the pinnace, and the other enables them to cut off or put on the steam. The

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pinnace, with no one in her, is then made fast to the launch, also with no one in her, and commences to tow the launch along the line of channel, the movements of the steam pinnace being controlled by the firing party. As the cable, which is triced up in bights by rope yarn outside the launch, becomes taut, the yarns break, and give slack, and when the strain comes on the cable branches of the torpedoes, the slip hooks hanging the torpedoes slip, and detach the torpedoes. When all are paid out, the whole are fired from the firing boat, and blow away the torpedoes of the defence along the line of channel. The operation is supposed to be done in the dark, we presume a light, showing only seawards, being carried by the steam pinnace. A few red buoys, attached by lines to the cable, are also dropped, to indicate to the fleet the line of channel cleared. The whole of the arrangements are ingenious, but might be greatly improved. We wonder that Mr. Sleeman does not allude to them. It should be noticed, however, that the Lay torpedo pays out a line through which she can be steered from a stationary point, and this is fully described and more fully illustrated than the Whitehead.

The author has, besides the description of the various torpedoes, including the Harvey, Lay, Whitehead, &c., collected a quantity of matter regarding the operations during the Russo-Turkish war, and various series of experiments that have been made from time to time. It is quite possible that to those professionally employed in the study, such as the Royal Engineers and Torpedo School in the Vernon, there may be nothing very new, and some omissions may be apparent, but to the general public we doubt whether there is any work that contains so much information. Indeed, the only work which contains any systematic account of torpedoes which has come to our notice before is the series of "Notes on Torpedoes," which ran through several numbers of *Engineering* some three years ago ; but these were never published separately. At the end of the work there is a careful and elaborate synopsis of the principal events that have occurred in connection with the history of the torpedo, giving date, operator, event, place, and remarks, commencing with 1585 and brought down to 1878. There is a good index, and altogether the volume evinces considerable work, and should be possessed by all who care for this interesting and important subject.

OBSTACLES TO THE SUCCESS OF EDISON'S SYSTEM.

CLEVELAND, OHIO, FEB. 3.—A well-known electrician of this city, who recently returned from a visit to Edison's laboratory at Menlo Park, has been indulging in some severe criticisms on the inventor and his work with regard to electric lighting. As these comments are in great measure based on statements of alleged facts, their truth or falsity can be readily inquired into. As a result of his inquiries, which were very thorough, he asserts that Edison has simply resurrected a lot of scientific lumber with the design of dazzling the public, which has forgotten the experiments of a like bewildering character that attracted so much attention thirty years ago. Taking up seriatim the claims of the inventor, or put forward in his behalf, said he, there comes first the assertion that the carbon horseshoe would last indefinitely without there being any indication of its differing from the incandescent carbon employed before. It was well known before incandescent carbon, even in a perfect vacuum, if heated sufficiently to be of any value as a light producing agent, could last but a short time, owing to a peculiar disintegration of the material, the cause of which has never been satisfactorily determined. It seems that Edison, in order to make his carbon horseshoes last a reasonable length of time, heated them to a comparatively low temperature only, thus sacrificing most of their light-producing power in order to add to their durability, which, after all, is quite limited. In this one point of want of durability, which has wrecked all previous experimenters during the past 34 years, he appears to have made no advance whatever. It has been assumed by Edison and the public that if this lamp could be made a success in the way of durability the problem of economical electric lighting by the incandescent plan would be solved. This is far from being the case. Success would be as hopelessly far off as ever. A question of economy would at once arise, and here the real difficulty will begin. Edison has carefully ignored or avoided this point, undoubtedly understanding fully where its discussion would land him. He called his lights 10 candle-power each. Even if they were of this size, no one would think of accepting one in place of a 16-candle gas-burner. But the fact is, they were by no means of 10 candle-power each, as any experienced observer could see at a glance, and no photometric measurements appear to have been made in the laboratory. Moreover, the light differs greatly at different aspects. For instance, when the edge of the horseshoe is presented, the light evolved is vastly less than when the side is viewed. Even granting 10 candles for the side of the horseshoe, the light from the edge is noticeably very much less. Mr. Edison claimed to produce four of these lights with a consumption of one horse-power in driving his generators, but promised to so improve his apparatus as to get 8 or 10 lights per horse-power. Even assuming these latter figures to have been attained, the hopelessness of the affair in an economical sense is apparent to any thinking person. But, in point of fact, it is doubtful if he can get more than two, or possibly three, of these small lights per horse-power under the best management.

It was perfectly apparent to this gentleman that, from the size of the belts conveying the power, from the rapidity of the revolution of the machines, and from the heating of the armatures and field magnets, each machine was absorbing from five to seven horse-power; and as he has never had to exceed 50 lights burning at one time it is evident that he is not now getting with his present apparatus more than three or, at the outside, four lights per horse-power.

The absurdity of the claims made for the so-called Edison generator, with which the electric current for Edison's lights has been produced, has been discussed and made sufficiently apparent by many scientific writers during the past few months. A critical investigation of this generator reveals the fact that it is a rather poor form of the well-known Siemens machine without any novel or additional feature.

Much has been said in connection with Edison's lamp about his great improvements in the well-known Sprengel air-pump (which he uses to exhaust the air from his lamp bulbs), by reason of which the time required to effect the exhaustion was reduced from 40 odd hours to 25 minutes, and through which the extraordinarily perfect vacuums of a millionth atmosphere was attained. In *Deschanel's Philosophy*—1873, page 198—Dr. Sprengel, the inventor of the Sprengel pump, says:—"From 20 to 25 minutes are required to exhaust a receiver of the capacity of half a litre." This is a much larger receiver than the Edison lamp bulb. Again: "By this instrument air has been reduced to one thirteen hundred thousandth atmospheric density, and the average exhaustion attainable by its use is about one millionth." It is easy to see where Edison borrowed his air-pump thunder.

The author of the article goes on to discuss in great detail the cost of lighting New York on Edison's system, and concludes that the cost of each light would, by this estimate, be 21 dollars a year. It would not be equal to the light furnished by a four-foot burner. At 1 dollar per 1,000 for gas, the average annual cost of a single burner to the consumer is 8 dollars, or 16 dollars at 2 dollars per 1,000. If gas were sold at 10 per cent. profit, it could be delivered in the holders for 40 cents per 1,000. The actual cost to the gas companies is less than 30 cents. Granting all his claims, Edison's electric light would entail an expense equal to that of a gaslight of greater brilliancy at 2 dollars 30 cents per 1,000, while the gas companies could make more money than the Electric Light Company, and sell it for 40 cents per 1,000.

Another point that does not seem to have been made clear by Mr. Edison, or at least about which he has said little, is the necessity for some automatic means of regulating the current delivered by his generators, so that sudden and great changes in the number of lamps being used at any time shall not affect the uniform working of his system. For instance, in lighting a large hotel, it would be necessary to have a sufficient amount of current provided to sustain, say a thousand lamps at one time, at 7 o'clock in the evening. Two or three hours later, perhaps, only half this number of lamps would be burning, and after midnight possibly not one-tenth. It will be at once evident that for the proper operation of the Edison system in such place, an automatic adjustment, or regulator of current, must be provided which will follow accurately, and with the utmost certainty, these changes in the number of lamps burning, so that when all are burning each one will give full light, and when one-tenth only are burning, each of them will give only its normal light. So far as the public knows, no arrangement whatever has been provided to meet this imperative necessity in such a system. In the recent article in *Scribner's Monthly*, written by one of Mr. Edison's *employés*, and accompanied by his autographic sanction, this vital point is not even mentioned. To those conversant with the subject, it does not seem possible to provide practically for this difficulty. At present, at Mr. Edison's a young man is stationed in the vicinity of the apparatus with his eye on the Thomson galvanometer, prepared to throw into the circuit more or less artificial resistance to provide for any changes of current caused by the increase or diminution in the number of lamps burning.—*New York Times*, Feb. 7.

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AUSTRALASIAN TELEGRAPHY.

The method of comparison, which is so often and so justly employed to elucidate many questions, is frequently adopted to show the progress of colonies and countries by comparing their energy in telegraphic matters. It is difficult sometimes to obtain authentic statistics upon colonial questions, but the Australian colonies set a good example in this particular, and furnish well-digested statistical information at regular recurring iuntervals. The Victorian statistics especially must be recognised as of the greatest value, and the Government statist, Mr. H. H. Hayter, must be congratulated for enabling us to estimate, without any great difficulty, the progress of this colony by the publishing of his admirable *Year Book*. From this we gather that Victoria in 1860 had thirty-three telegraph stations open; these sent during that year 166,803 telegrams. Five years later there were seventy-nine stations, with over 3,000 miles of wire, and the number of messages transmitted was 279,741. Ten years later, that is in 1875, the number of stations had increased to 164, the miles of wire to 4,510, and the number of messages to 732,869. The last year for which the statistics are complete is 1878, which again shows a large increase in every direction over the previously mentioned period. The stations open amounted to 233, with 5,404 miles of wire, and transmitting during the year 1,003,614 messages. We shall compare these figures with those of other colonies, but before doing this it may be as well to say that we have every reason to suppose that the mother country has supplied, and still supplies, the telegraphic apparatus required in these colonies.

Quite recently, since the opening of the Sydney Exhibition, a large order for scientific apparatus has been given by the Colonial Government to America. This apparatus is such as is used by civil engineeers in surveying, and hitherto has been supplied from England. It behoves our manufacturers of telegraphic apparatus, then, to bestir themselves, and to see that no order for scientific apparatus as made by them goes to our rivals across the Atlantic. The Australian Governments are justified in supplying their wants from the cheapest market. This is free trade. Our manufacturers have to see that the wares they offer are cheaper or better at the same price than those of their competitors. The tariff is the same for all, and it may be interesting to note this tariff, say for iron wire. The tariff of Victoria is 20 per cent. *ad valorem* on many metals, but wire is free; of New South Wales £1 per ton, of Queensland £2 per ton, of South Australia £1 per ton; Western Australia exempts telegraph instruments, wire, and insulators, and New Zealand also exempts wire.

To return to the comparison of progress between the colonies. Taking the years 1873 and 1878, we notice that Victoria increased from 2,295 miles of line at the former period to 2,970 miles at the latter, that is at the rate of 135 miles per annum; Queensland during the same period advanced from 3,059 miles to 5,410, the average yearly increase being 470 miles; Western Australia from 750 to 1,581, an average increase of 160; Tasmania from 291 to 825, an average increase of 106. New Zealand commenced the period with 2,389 miles, as against 3,434 at the end, showing an average increase of 209 miles. The statistics for New South Wales are given for only two years, the increase being during the year over 1,000 miles, while South Australia shows an average increase for three years of 246 miles. This annual increase will, no doubt, be modified in the future, but for the five years under consideration it will be seen to have been at the rate of about 2,000 miles per annum. We again say that the business this shows with the mother country is by no means to be despised, or to be lost through a mistaken idea that the colonies are compelled to come to England for what they want. During the year 1878 the value of telegraphic wire imported by Victoria is stated to have been £3,084, and of telegraphic materials (wire excepted) £8,123, or a total of £11,207. A small portion of this was exported to other colonies, but by far the greater part was for the colony itself.

The information we have here gathered is supplementary to that given in the paper on "New Zealand Telegraphs," read at the meeting of the Society of Telegraph Engineers on Feb. 11th. It is doubtful if those engaged in colonial telegraph work have ever rightly understood that periodical statistics as to progress are valuable, and the fact has only to be grasped to solve the difficulty experienced in obtaining authentic details. We have now to wait till a whole series of statistics has been compiled before getting the information we want, when a few minutes, say in the last week in December in each year, spent in preparing a short tabulated statement would give, so far as telegraphy is concerned, all that we require. Now we can compare to the end of 1878, but we ought to be able to compare to the end of 1879.

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CORRESPONDENCE.

THE ESSENTIAL NATURE OF ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I desire to contribute a mite to the interesting controversy now raging on the essential nature of electricity.

It has been asserted by Mr. Preece, that that which we call electricity must be either a form of matter or a form of force, and that "there is no other category in which to class it." Mr. Sprague agrees with Mr. Preece in choosing the latter horn of the dilemma. Mr. FitzGerald has modestly denied the dilemma. To his gentle suggestion I wish to add a few sentences.

Modern physicists recognise three fundamental quantities, *mass*, *time*, and *space*, the first two admitting only of measurement in one dimension, the latter admitting of measurement in three dimensions. From these fundamental quantities they derive all other exact units, as may be seen in any modern work on dynamics.

Thus a *velocity* is $\frac{L}{T}$, or L^1T^{-1};

an *acceleration* is $\frac{L}{T^2}$, or L^1T^{-2};

a *momentum* is mass × velocity $= \frac{ML}{T}$, or $M^1L^1T^{-1}$;

a *force* is mass × acceleration $= \frac{ML}{T^2}$, or $M^1L^1T^{-2}$;

and *vis-viva* or *energy* is force × distance $= \frac{ML^2}{T^2}$, or $M^1L^2T^{-2}$.

Now, if we inquire what is the *strict* meaning of Mr. Preece's words we shall see that they amount to this: there are only two categories in which to class natural agencies. They either have the dimensions of M or of $M^1L^1T^{-2}$. Or, supposing that we take Mr. Preece to mean form of "energy" where he says form of "force," the dilemma lies between M and $M^1T^2L^{-2}$. Stated in this bald but exact way, the proposition that electricity must be either a form of matter or a form of force, because there is no other category in which to class it, is simply untrue. We do not build up a dilemma for ourselves, and say that a velocity or a momentum must necessarily be either a form of matter or a form of force, we give them categories of their own. Mr. FitzGerald is quite right in claiming for "that which we call *electricity*," and express in symbols by $Q = \frac{E}{R}t$, &c., a right also to be placed in a category of its own. What are the "dimensions," then, of "that which we call electricity?" Let us take the electrostatic measure of electricity, as the simpler, and deduce it simply from the law of inverse squares. When defined in absolute units, the force exerted between two quantities of electricity is equal to their product divided by the square of the length between them, or

$$\frac{Q \times Q'}{l^2} = f = MLT^{-2}.$$

Remembering that Q and Q′ are simply multiples of some unit q, we shall find the "dimensions" of this q as follows:

$$q^2 = fl^2 = ML^3T^{-2},$$

and $$q = M^{\frac{1}{2}}L^{\frac{3}{2}}T^{-1}.$$

Obviously, a quantity which is of these "dimensions" with respect to mass, length, and time is not to be classed in any of the above categories; it is certainly not in the same category as "matter," or "force," or "energy." Every student of the theory of electricity knows that a precisely similar expression can be obtained for the "dimensions" of the strength of a magnetic pole.

Having thus disposed of Mr. Preece by the help of the "dimensions" derived from the fundamental units of mass, space, and time, I propose to demolish, by the same agency, the whole of Mr. FitzGerald and Mr. Sprague—not to add Faraday and a few other physicists—by proving that "that which we call electricity" is of the same dimensions as that which we call "matter," and which is known to us by possessing mass, or of which "mass" expresses the quantity in a body. Matter, like electricity, obeys the law of the inverse squares, but with this difference that it attracts itself instead of repelling itself. By a precisely similar system of reasoning to that employed above, we may say—"When defined in appropriate units, the force exerted between two quantities of matter is equal to their product divided by the square of the length between them;" or

$$\frac{\mu' \times \mu''}{l^2} = f = MLT^{-2}.$$

Remembering that μ' and μ'' are simply multiples of some unit of mass M, we get

$$M^2 = fl^2 = MLT^{-2} \times L^2,$$

or $$M = L^3T^{-2}.$$

A mass, then, appears to be of three dimensions with respect to length, and of two dimensions negatively with respect to time. Now, substitute the value of M thus obtained in the expression obtained a little while ago for q,

$$q = M^{\frac{1}{2}}L^{\frac{3}{2}}T^{-1} = L^{\frac{3}{2}}T^{-1} \times L^{\frac{3}{2}}T^{-1},$$

or $$q = L^3T^{-2},$$

from which it appears beyond cavil that q, or "that which we call electricity," is of the same dimensions as M, or "that which we call matter." But whether this once more reinstates Mr. Preece in his dilemma I leave to others to speculate, and would invite on this point the attention of Mr. Sprague, Mr. FitzGerald, Professor Ayrton, Dr. O. J. Lodge, and our electrical theorists generally, and remain only an

IGNORAMUS.

NOTE ON ELECTROLYTIC EXPERIMENTS.*

By JAMES DEWAR, M.A., F.R.S.

Having had occasion to employ the intermittent current of the de Meritens magneto-electric machine arranged for intensity in connection with spectroscopic work, the following notes of electrolytic experiments made by means of it may not be without some interest.

The number of intermittent currents taking place in the circuit during the course of the following experiments may be taken as about 300 per second, and as the amount of energy in circulation is very considerable, an examination of its action on electrolytes was of some interest.

Dilute sulphuric acid, of about 1 of acid to 6 of water, used as the electrolyte in a large circular glass vessel, gave the following results:—

On placing two rather large platinum poles, each exposing a surface of about 32 square centims., no decomposition took place; a few bubbles of gas came off at one pole for a short time, which soon ceased. The current was proved to be passing by placing a telephone near the side of the glass vessel, and also by the rapid increase in the temperature of the acid, which very soon reached the boiling point. The absence of decomposition was due to the rapidity with which the current in the de Meritens machine is alternated, the gases given off at each pole being rapidly superposed and combining immediately to form water.

Decomposition was immediately produced by making and breaking the current rapidly with the hand, or better still, by placing a large tuning fork in the circuit, to which was attached a copper rod which dipped in and out of mercury at every vibration of the fork.

When two poles were used, consisting of platinum wire, decomposition went on without intermission at both poles; but, on the other hand, when one pole was a plate of platinum and the other a platinum wire, the mixed gases were given off at the wire pole only.

The spectrum of the platinum poles, viewed with a small direct vision spectroscope, was very complicated, showing the H and air lines.

Platinum wire of about ·5 millim. in diameter, used as one pole, readily fused when held close to the surface of the liquid, and remained white hot when immersed below the surface, with a continual ejection of the particles of the fluid and successive small explosions of the mixed gases.

Aluminium wire behaved in a remarkable way when used as one of the poles, the other pole consisting of a large surface of platinum. On first plunging the wire beneath the surface nothing is observed; almost immediately, however, it becomes intensely illumiated all over the surface. The light seems to emanate from an immense number of points which look like lit-up gems. This appears to be due to the formation of oxide of aluminium, which offers a great resistance to the passage of the current, and consequently becomes intensely heated, and is pierced or disintegrated at certain points; and this supposition seems to be confirmed by the absence of any incandescence of the wire when hydrochloric acid, caustic potash, or any other medium which dissolves the oxide as soon as formed is used. If another aluminium wire is substituted for the platinum plate, then either the one or the other becomes illuminated according to the extent of surface of metal immersed, but they are generally not illuminated at the same time, the largest surface always

* Abstract of a paper presented to the Royal Society.

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remaining dull; gases are now freely given off, being chiefly hydrogen.

The luminosity of the aluminium wire becomes very much diminished after a short time, as the wire becomes almost completely covered with a uniform layer of the white oxide, and is gradually eaten away. The luminosity can again be produced by cleaning the poles. The same effects took place when dilute hydrochloric acid, or saturated chloride of sodium was substituted for the dilute sulphuric acid. After the current had passed for some time gas was given off at both poles.

The light evolved from the surface of the poles below the surface of the electrolyte was intensely white, and, on spectroscopic examination, proved to be the characteristic channelled spectrum of oxide of aluminium first described by Thalèn. The characteristic metallic lines between the two H lines were faint.

On bringing a piece of thin foil aluminium as one pole near the surface of the acid it is immediately fused, globules of the melted metal flying about in all directions; the aluminium wire is also fused after a short time, and falls through the liquid in white hot globules.

Magnesium wire at one pole, the other being the platinum plate as before, gave an intense green colour below the surface, a spectroscopic examination showing the combined spectrum of the metal and oxide.

It burnt on the surface of the liquid in the same manner as the aluminium, showers of melted metal being thrown off; the action when a saturated solution of chloride of sodium was employed was, if anything, more intense. Similar actions took place with other metals, such as copper, zinc, &c.

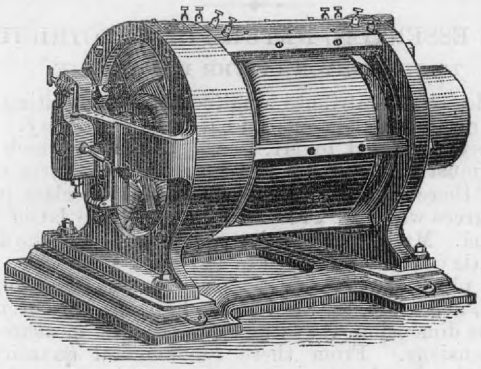
A solution of chloride of sodium was rapidly decomposed, abundance of chlorine being set free, when a platinum wire was used as one pole, the larger platinum plate being used for the other. A solution of iodide of potassium behaved in the same way, but was decomposed at a very much slower rate when both the poles were of large surface. A saturated solution of sulphate of copper deposited hardly a trace of copper, when the platinum plate and a thick platinum wire were used as the two poles. Various modifications of these experiments may be made by employing different metals. The intensity current used with a saturated solution of nitrate of potash, has the power of engraving on glass, as described by von Plante.

The determination of the heat evolved from the Jablochkoff candle in the annular calorimeter, formerly described, amounted to about 6,000 gram-units per minute, or, in other words, it is about one-sixth of the total radiation of the Siemens machine when the small resistance of the electric arc is alone in the circuit.

On introducing into this circuit containing a Jablochkoff candle the voltameter which was formerly used, and in which no decomposition was apparent when used alone, the total radiation of the candle was very slightly diminished, but the cell showed intermittent bursts of electrolytic gas, just as when the tuning fork was used as formerly described. This seemed to be always associated with any quality of intermittence due to the want of regularity in the action of the candle. Assuming that the whole work of the intermittent current was exhausted first in electrolysis, and then in recombination of the separated electrolytes, and that recombination resulted solely in a heating effect localised in the cell, then the elevation of temperature would be a measure of the chemical work done. As, however, the amount of this heating is relatively small in comparison with the current circulating, we must suppose that a considerable portion of the energy of recombination is thrown into the circuit as a new electromotive force. The chief interest in these experiments is the value of the de Meritens machine, as having many of the advantages from Plante's secondary piles, and the facility and ease with which this power can be used. The recent experiments of Spottiswoode have shown that the character of the arc obtained from the de Meritens machine is intermediate in qualities between that of the ordinary arc and that of the induction spark, and may be employed with great advantage in exciting the induction coil. The use of it in spectroscopic work has been fully detailed to the society in conjoint communications with Professor Liveing. The luminious discharge obtained below the surface of fluids shows another valuable use of the machine in connection with this subject.

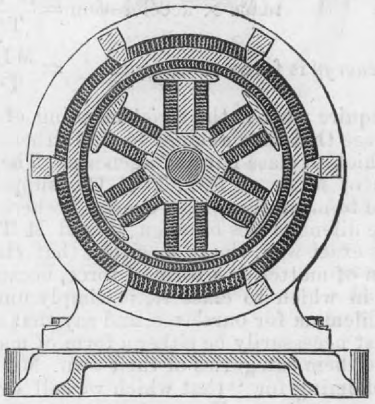
A NEW GRAMME MACHINE.

M. Hippolyte Fontaine describes in the *Révue Industrielle* a new Gramme machine, diagrams of which we believe were exhibited by the British Electric Light Company at the recent *conversazione* of the Physical Society at King's College. In his old machine, M. Gramme used a small continuous machine (the exciter) to send a current through a larger machine, which has been termed the distributor. The inventor has now combined the two machines, and obtains better results than when they were separate. The accompanying illustrations almost explain

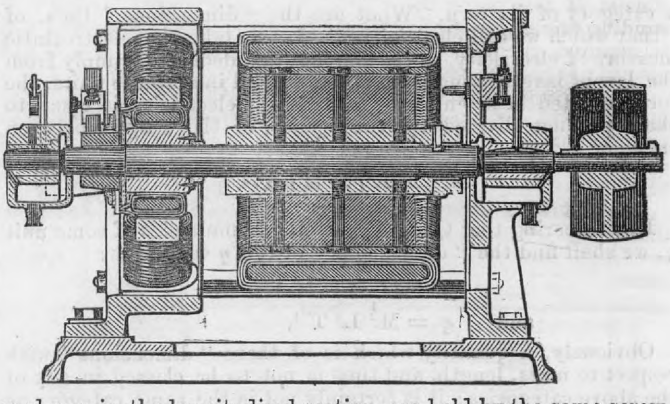


themselves. The arrangement is thus made :—On a low cast-iron bed are bolted two almost circular cast-iron plates, connected together by six square bolts, and provided with bearings for the main shaft. One of these plates is furnished on the inner side with an annular rib on which the electro-magnets of the exciting apparatus are fixed. As in the earlier machines the coils for the alternating currents rest on these square bolts, connected to the end plates by means of packing pieces of hard wood.

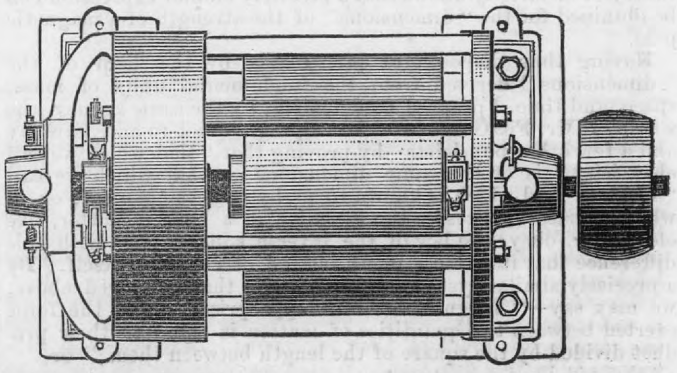
The movable electro-magnets, six in number, are fixed radially



round a hexagonal piece, bolted on the shaft. The armatures,



as shown in the longitudinal section, are held by the same screw. On one side the shaft carries the small exciting coil, on the other



an induction coil. The bearings are large, and in the larger machines are automatically lubricated.

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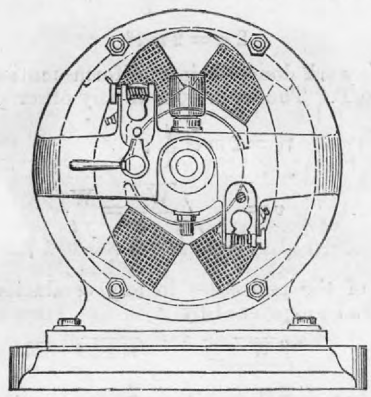
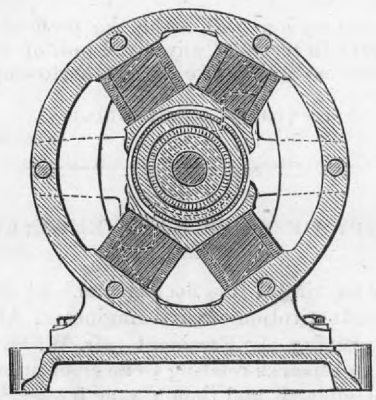
A small handle serves to put the movable electro-magnets in





communication with the current of the exciting coil. This current is collected and transmitted by brushes of silvered copper wire. The brushes work by means of an endless screw, furnished with a counter screw placed outside the frame. To regulate the magnetisation of the inductors, and, consequently, the power of the machine, M. Gramme has fixed between the exciting coil and the electro-magnets a copper wire, the length and section of which can easily be varied. The winding of the wires upon the coil differs somewhat from that of ordinary machines, which consist of two parts, the exciter and distributor. Instead of winding one single wire at a time he winds two, in order to have, as required, currents of tension for small candles, or currents of quantity for larger candles.

Two types of these machines are now made :—First, one weighing 280 kilos, and supporting 12 candles of from 20 to 30 becs each, or eight candles of from 40 to 50 becs each ; second, one weighing 470 kilos, and supporting either 24 of 20 to 30 becs, or 16 of 40 to 50 becs each.

The following experiments have been made with these machines :—

Order.	No. of Revolutions per minute.	Motive Power in kilogrammètres.	No. Foci.	Intensity of each focus in Carcel becs.
1	1,140	145	2	45
2	1,200	204	4	47
3	1,330	230	6	44
4	1,400	380	8	42
5	1,440	352	12	25
6	1,350	310	8	38
7	1,300	287	6	37·5
8	1,300	334	6	50·2
9	1,460	376	8	47·2
10	1,000	—	16	43
11	1,020	—	20	51
12	1,200	—	25	31·5

The first four experiments were made with a small machine, worked by an Otto gas engine. The coils were made to form successively two, three, and four distinct circuits. The expenditure of motive power was measured by a Prony break. The candles used had carbons 4mm. diam., and lasted two hours. Experiments 5, 6, and 7 were made on the same machine, coupled in tension. The candles had carbons of 3mm. diam., and lasted 1·5 hours.

The division of the light weight has been pushed further; but it was observed that, when reduced to an intensity of 20 becs, the candles lost much of their regularity. Only one experiment was made in this direction. With a machine specially arranged for small lights, there were obtained, with a velocity of 1,250 revolutions, 14 foci of 20 Carcel becs, with an expenditure of motive force of 350 kilogrammètres. The candles used had carbons of 3 mm in diameter.

Experiments 8 and 9 were made with a small machine, with the help of a steam motor, the speed of which varied considerably. Several candles went out during the working, but, when the speed was slightly accelerated, this accident no longer occurred.

Experiments 10, 11, and 12 were made at the works of the Société Jablochkoff, at Paris, on two of the larger machines. They are shortly to be repeated on the Place de l'Opéra.

In all the experiments a greater fixity of light was observed than in machines possessing independent exciting coils. It is stated, moreover, that the price of the new apparatus is about 50 per cent. less than that of the old. Two years ago the Gramme machines cost 1,000f. for 16 lights, and half that amount for six lights; whilst the *bougies* cost 75 centimes, and lasted for one hour and 20 minutes. At the present time the machines are sold at 4,500f. for 20 lights, and 2,800f. for eight lights; whilst the *bougies* cost only 50 centimes, and last for two hours and 10 minutes. Great progress has, therefore, been effected from an economical as well as from other points of view; nor is there any reason to think that the maximum reduction in cost has yet been effected.

CONTRIBUTIONS TO A PHYSICAL THEORY OF ELECTRICITY.

BY DESMOND G. FITZGERALD.

(CONTINUED FROM P. 137.)

On the Molecular Motion by which Electrical Conduction is Effected.

In producing the motion of masses, we ordinarily encounter a very appreciable initial resistance (which I have called ϕ) which may be due to friction, adhesion, or mechanical defects; and this resistance prevents the dynamical action of any force smaller than ϕ. In the case of molecular motion—where the mechanism for the conversion of potential into kinetic energy may be said to be perfect—we do not generally observe any such initial resistance; and the smallest force we apply to produce the motion of molecules seems to exert instantaneously a corresponding dynamical effect. We are careful to use the expression "seems;" for it is a question for inquiry whether there is not in all cases an initial resistance opposing the production of molecular motion, and increasing with the dynamical force so as effectually to prevent dynamical effect during some minute period of time.

It may be interesting to give at once some illustration of these observations. The illustration may subsequently serve in the consideration of the *momentum* which accompanies molecular motion. Let us first consider the case of a rectilinear conductor, a few hundred feet in length, and of negligible electrostatic capacity, successively traversed by currents under varying electromotive forces. The mechanico-dynamical effect will always be exactly proportionate to E^2, that is to say to the square of what is termed the electromotive "force;" and the electro-dynamical effect, or the current, will vary exactly as E, that is to say as the square root of what we maintain to be the force in action. So far as we can experimentally ascertain, these effects are *instantaneously* produced on the completion of the circuit. We know that they are not instantaneously produced, since there must be some electrostatic "retardation;" but the present point is that, even if we suppose the electrostatic charge to be *nil*, it can be shown that there is, in this case, an initial resistance which constitutes a totally distinct cause of "retardation," and which must be active during some small space of time. We refer to "electro-magnetic retardation," a phenomenon of which the full import is far from being recognised, and which is worthy of the most careful study from the point of view of theory. If we coil our wire into a helix, traces of this retardation may, under certain conditions, be readily observed. For instance, if we carefully balance the resistance of our wire on the Wheatstone Bridge, so that no deflection is produced on a delicate galvanometer when the instrument is made to connect the two branches of the circuit *after* the current has been established in them, and if we then connect up the galvonometer *before* the current is established, the needle may be strongly deflected when the circuit is completed. This deflection indicates that our coiled wire momentarily offers a resistance considerably in excess of its normal resistance. A slight study of the phenomenon suffices to show that it is dependent upon the quantity of *magnetic work* done in the circuit. Thus, if a core of soft iron be introduced into the helix, the effect of electro-magnetic retardation becomes greatly intensified. Let us now, making a scientific use of the imagination, exaggerate the phenomenon by taking the suppositious case of a circuit composed of an indefinite number of electro-

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magnets having a small aggregate resistance, and including a battery and a galvanometer. What would happen on completing such a circuit? I think it may safely be said that, for an indefinite period of time, no appreciable current would be indicated by the galvanometer and no heat would be generated in the wire. Have we, then, here a case in which the battery becomes totally inactive, as when an electromotive force equal to its own is opposed to it? Not at all. It may be stated with certainty that chemical action would take place, and that zinc would be rapidly dissolved, within the cells. And what would occur on breaking the circuit—say after it had been completed during a full minute of time? With equal certainty, it may be stated that nearly the whole dynamical and electrical effect, corresponding to the *total* quantity of zinc dissolved and to the quantity dissolved *in each cell*, would then be instantaneously produced, with somewhat startling effect. But is not this phenomenon analogous in some degree to electrostatic discharge, or to that which would occur from a "polarised" secondary battery? Not in the least; the current which passes on breaking the circuit is in the *same direction* as that in which the current from the battery would ultimately pass—it may in fact be said to be *the* battery current, suddenly exhibited.

Now, it is well known that a rectilinear conductor traversed by a current possesses magnetic polarity; and the precise nature of this polarity, as well as the fundamental cause of it, was considered in a paper contributed by the writer to *The Electric Telegraph Review* of Aug. 27, 1870. Magnetic work is therefore done by a current in such a conductor, and it necessarily follows that the phenomena of electro-magnetic retardation to which we have referred must, to some minute extent at least, occur on the completion of any conductive circuit. These phenomena, however, may be neglected in considering the *modus agendi* of electrical conduction in its simplest aspect. We may assume that any "electromotive" force acting during an appreciable space of time, will produce motion in the molecules of a conductor, according to the direction and the magnitude of the force. This assumption, which will be made more specific as we proceed, is in reality merely a tentative application of elementary dynamical principles, and, if incorrect, will speedily lead us into a *reductio ad absurdum*. For it is not without reason that the science of mechanical dynamics has been termed the "key to Nature"; its principles are applicable, if accurate analogies be found, in every branch of physical science, and especially in molecular physics; and of it may be said, what has less truly been said of science in general, "that it may correct itself, but that nothing else can correct it."

We have seen that when a continuously diminishing acceleration results in uniform motion, the resistance R opposed to this motion must necessarily be equal to the force producing the motion, or $R=f$. When the initial resistance ϕ disappears, the mean resistance during the period T of variable motion becomes $\frac{R}{2}=\frac{f}{2}$, and the mean accelerating force also becomes $\frac{f}{2}$. The equation (p. 136) for the period of variable motion thus becomes

$$T=\frac{2mv}{f};\text{ and, since } v=\frac{2s}{T},\ T=2\sqrt{\frac{ms}{f}}.$$

Now, by the principle of the conservation of energy, we have

$$\frac{R}{2}s\times\frac{mv^2}{2}=fs=w,$$

and, since $\frac{R}{2}=\frac{f}{2}$,

$$fs=mv^2,\quad f=\frac{mv^2}{s}=\frac{2mv}{T},\quad\text{and } v=\sqrt{\frac{w}{m}}.$$

Here v is the maximum velocity, s is the space moved through in the time T, and w is the work done in the same time.

When the motion becomes uniform, the space s will be moved through in the time $\frac{T}{2}$, and, if t be any given period of time, the total space moved through in this time will be

$$S=s\frac{2t}{T}=s\frac{tf}{mv}.\quad\text{(From the equation for T).}$$

$$\text{but } s=\frac{mv^2}{f};\ \text{ therefore } S=\frac{mv^2}{f}\times\frac{tf}{mv}=vt.$$

The power in action will then be doubled, or

$$\frac{W}{t}=\frac{fS}{t}=2\frac{w}{T}=\frac{2fs}{T}.$$

$$\text{And we have}\qquad W=fS=fvt;$$

$$\text{but}\qquad f=\frac{mv^2}{s}=\frac{2mv}{T}.$$

Multiplying by $2s$, we have, since $\frac{2s}{T}=v$,

$$2w=2mv^2.$$

This will be the work done, during uniform motion, in a period of time equal to T. The work done in any other period t will be

$$W=2mv^2\frac{t}{T};$$

$$\text{whence}\qquad v=\sqrt{\frac{W}{2m\frac{t}{T}}}=\frac{W}{ft}.$$

The velocity of the molecules in any conductor conveying a current will thus be expressed by

$$v=\sqrt{\frac{W}{2m\frac{t}{T}}}=\sqrt{\frac{EIkt}{2m\frac{t}{T}}}=\frac{EIk}{f};$$

k being a constant such as will make the product EIk express the electrical work in terms of any given unit of work, *e.g.*, the foot-pound-second unit which we have hitherto employed.

(TO BE CONTINUED.)

SOCIETY OF TELEGRAPH ENGINEERS.

The ordinary meeting of this Society was held on Wednesday, 25th inst., at the Institution of Civil Engineers. After the formal business of the evening, the President (Mr. W. H. Preece) made some explanatory remarks relating to an error on matters of fact in his inaugural address, and then a very interesting and useful discussion was carried on by Mr. Willoughby Smith, Mr. Adams, Mr. Morgan, Prof. Ayrton, and Prof. Hughes, on the question of Electro-static and Electro-dynamic Induction. A short paper by Mr. J. B. Stearns was then read by the Secretary on

A Fault in the Construction of Differential Instruments.

The author drew attention to the inconstancy of the balance in a differential mirror galvanometer. Various causes affecting this loss of balance were mentioned, and the author stated that about a year ago he thought he had found one cause for this variation in the differential galvanometer, and had communicated his observations and conclusions to the President. These observations were then described. He had a mirror galvanometer wound differentially, and carefully adjusted till the effect was *nil*. Then he joined up in parallel circuit, and added external resistance to one of the wires till the effect was *nil*. For some time satisfactory results were obtained, but then it was found to be unbalanced, and the spot of light moved. Several turns had to be taken off one of the wires to again make it balance accurately. A more sensitive mirror was employed, and the galvanometer adjusted. On restoring the former mirror it was found to be much out of balance. It was found that if the tube carrying the mirror was pushed in or drawn out a trifle it changed the balance. This action is puzzling. If we suppose that in the differential galvanometer there are two magnetic fields of exactly the same extent and intensity, but of opposite polarities, then all parts of the magnetic field are neutral. Then why this action? The author's explanation is—In winding it is usual to wind two wires from separate bobbins, holding the two wires firmly, and allowing the wires to slowly traverse the coil from right to left, and back again, and so on till the work is finished. On the whole the wire from the right hand bobbin will be to the right in the coil, and nearer the right hand end of the coil than the other wire by at least the diameter of the wire, but it happens frequently that the two wires become separated to the extent of $\frac{1}{10}$in. or more, and one cause of loss of balance is due to this. To remedy this fault in differential instruments, the relative position of the two wires at every position must be changed, that is, the wire that was on the right while winding the first layer should be on the left in winding back on the second layer, and so on. The same correction might perhaps be secured by twisting the two wires together before they were wound, but this is generally objectionable.

It was also noticed that a slight change in the levelling screws produced this want of balance. This renders it the more important that the defect in the construction of the differential instruments should be remedied.

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SIR CHARLES WHEATSTONE.

(A discourse delivered by Mr. W. H. Preece, at the Royal Institution, on Friday evening, 13th February, 1880.)

(CONCLUDED FROM P. 166.)

Having succeeded so far in obtaining simplicity, Wheatstone turned his attention to the practicability of sending telegraphic signals by machinery without the aid of the hand in manipulation, and thus increasing the capacity of wires for carrying messages. Siemens in Germany, Bain in England, and others had been working in a similar field, and in 1858 the genius of Wheatstone, combined with the mechanical ingenuity of Stroh, developed an entirely new system of automatic telegraphy on the principle of the Jacquard loom. A paper ribbon was passed through a piece of mechanism consisting of three keys with knives or cutting punches, which, when pressed on the paper, perforated it according to the key depressed. The centre key cut a continuous row of holes, which were used to push forward the paper. The left hand key cut two holes directly opposite each other, and represented the left hand beat of a needle, or the dot of the Morse alphabet. The right hand key cut two holes, one above and one below the middle row, but in a slanting direction from left to right, and represented the right hand beat of a needle, or the dash of the Morse alphabet. The paper so perforated was then passed through the automatic transmitter, the action of which I can, perhaps, make clear by the use of a model.

Wheatstone's automatic instrument transmits a succession of currents of electricity in opposite directions, and if no paper were interposed to prevent these currents going except at the proper time, this succession of currents would be continually transmitted. (A model of the transmitter was explained in detail.) So that when no holes present themselves to the rocking prongs for the currents to pass through, nothing goes to line; but if two holes, representing a dot, present themselves, then a current passes, and a dot is produced at the receiver; and so, if the holes representing a dash admit the prongs, a dash is transmitted to the receiver. Each reversal of the current forms a dot, and if the reversal is stopped, a dash is formed; and it is by controlling these reversals with the perforated paper that reversals are sent at the proper time to make the required signals. I have an actual apparatus fitted up here in connection with the Central Station, and we will set it going and see what news is passing on the wire on which the instrument has been placed. At the present moment I may tell you that this wire is transmitting intelligence to distant offices, and our instrument is placed on it so that by setting it going we can see for ourselves what is passing. [Odd items of news were read off by the assistant.]

When Wheatstone invented this apparatus it was only workable at an average rate of seventy or eighty words a minute, but scientific training, observation, thought, and care have resulted in improving upon this so much that, on making inquiry yesterday morning, I found that one of our Wheatstone instruments was actually working at the rate of 180 or 190 words a minute. When the Queen's Speech was transmitted to the country last week it was sent to several towns in five minutes, and as it contained 800 words, the average rate was 160. To long distance places it is not possible, from various causes, to maintain this high rate without the insertion of a translator or repeater, which receives what I may call the almost exhausted signals, and sends them on reinvigorated to their destination. Until recently the rate of working between London and Cork was sixty words a minute, but, by inserting a repeater at Haverfordwest, this speed was doubled. The repeater is a complicated instrument, and I will not cause a headache by attempting to describe it. Its function, reduced to simple words, is, that it receives the currents from London, and transmits them to Cork. Repeaters are being generally introduced on our long circuits. To apparatus not on Wheatstone's principle repeaters can also be applied, and has been done in duplex apparatus.

Wheatstone's great achievements were the needle, alphabetic, and automatic instruments. The first telegraph was erected on the Camden incline, and is now called the fossil telegraph, through it only dates as far back as 1837. It consisted of five wires inserted in wood, and five needle instruments were fitted at each end. On recent operations going on where this old line was laid, portions of it were dug up, and I have a piece now before you.

Here is a photograph of an original document referring to the early needle telegraph. It is now reflected on the screen, and you see that in the year 1842 "under the special patronage of Her Majesty and H.R.H. Prince Albert the public are respectfully informed that this interesting and extraordinary apparatus, by which upwards of fifty signals can be transmitted 280,000 miles in one minute, may be seen in operation daily (Sundays excepted), from 9 a.m. till 8 p.m. at the telegraph office, Paddington, and telegraph cottage, Slough. Admission 1s.!"

Here is another placard which was distributed all over London at the same time as the previous one, and which speaks of the telegraph in the same eulogistic terms:—"The galvanic and electric telegraph, Great Western Railway, may be seen in constant operation daily [one would think we were going to the Polytechnic] (Sundays excepted);" and goes on to say that "by this powerful agency murderers have been apprehended, thieves detected, and lastly (which is of no little importance), the timely assistance of medical men has been procured in cases which would otherwise have proved fatal." There are some of the brilliant ideas thought of Wheatstone's telegraph in 1842. Everyone knows of the enormous development of the telegraphs. In 1870 the commercial part of the business was transferred to the Government, and at that time the business done in four weeks represented 554,000 messages. In the four weeks just expired it was 1,900,000. In the metropolis alone, while the number of messages of all sorts dealt with in four weeks in 1870 amounted to 130,000, in the four weeks just passed there were 726,000. It is very curious to note, in quoting these figures, that the high figure of the past few weeks is to a large extent owing to the tremendous fogs we have had, which were the cause of a marvellous increase in telegraph business. Pecuniarily, therefore, from this point of view, fogs are not objectionable. The traffic for two days at the Central Station in February, 1870, was 14,000; during the past week the average has been 40,000.

But it is in the transmission of news where Wheatstone's telegraphic achievements have proved of such marvellous benefit. In 1871 there were distributed to the different papers copies of messages, some 2,000 words long, others as short as 10 words, a total of 32,000. In 1849 they amounted to nearly 50,000. The number of words delivered in one week in 1871 was 3,598,000; in 1879 they amounted to nearly 6,000,000, which means 300 millions for the year, or 15,000,000 columns of *The Times*. There is not a large town in the United Kingdom possessing a newspaper that is not in direct communication with London for news purposes, and by this means every man receives at his breakfast table the latest item of news, Parliamentary or general, just as readily as we do in London. And all this is done by the Telegraph Department with the Wheatstone apparatus. In 1870 there were only six wires used for special Press purposes, now there are twenty-four. Besides the million words sent a day, there are newspapers in Glasgow, Dublin, and Edinburgh that rent wires for themselves, fitted up with different kinds of apparatus, by which they transmit all the debates of the Houses, &c.

In 1870 the number of Wheatstone alphabetical instruments was 1,200, now 5,000 are in use. There are now 151 circuits worked by the Wheatstone automatic apparatus, in 1870 there were only eight. This system has proved its superiority for the rapid despatch of news, and, in time, will, no doubt, be adopted by all countries employing the telegraph. I have not the slightest hesitation in saying that our telegraphic apparatus (thanks to Wheatstone) is at the head of that of the world, and my own impression is that the time is not far distant when even America will take advantage of the inventions we are now using.

On the table before you are specimens of the telegraphic achievements of Wheatstone which are worthy the attention of those who are interested in the subject.

One of the chief characteristics of Wheatstone was his extreme devotion to science. I doubt whether any one ever gave himself up so completely to science, in any shape or form. He was not a philosopher, nor was he a deep investigator; but he was essentially a great experimenter, and the chief merits of his apparatus were their wonderful originality, their refined beauty, their marvellous fecundity, and their eminent adaptability for the purposes for which they were designed. I told you he was no lecturer, nor was he a prolific writer; but he was an unrivalled conversationist, and those who had the pleasure of his conversation could never forget the lucidity with which he explained his apparatus. His bibliographical knowledge was almost incredible. He seemed to know every book that was written and every fact recorded, and any one in doubt had only to go to Wheatstone to get what he wanted. His power of deciphering puzzles was marvellous—it was instinct. A secret despatch of Charles I., that puzzled everybody since the days of that monarch, was placed into Wheatstone's hands, and was almost instantly explained. His mind, as I told you, was eminently practical. His powers over the little forces of Nature are shown by his telegraphic achievements in the beauty of the apparatus before you. The elegance of the design of everything Wheatstone accomplished must always maintain him in the very first rank of the wonderful geniuses of this wonderful century.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).

Report of the directors, to be submitted to the shareholders at the sixteenth ordinary meeting to be held on Tuesday, the 2nd day of March, 1880. The directors have the pleasure to submit their sixteenth annual report to the shareholders. The accounts for the year show a net profit of £98,988 5s.9d., after charging the interest on the debentures. To this sum must be added £59,353 3s. 6d. brought forward from last year, making a total of £158,341 9s. 3d. From this amount is deducted the interim dividend of 5 per cent., paid July 23, 1879, amounting to £22,410, leaving £135,931 9s. 3d. to be dealt with. Of this sum the directors propose to distribute a dividend of 15 per cent., or £67,230, being at the rate of £1 16s. per share, and making, with the amount already paid, a total dividend for the year of £2 8s. per share in cash, free of income tax, leaving £68,701 9s. 3d. to be carried to the next account. The operations carried out during the year 1879 have been as follows:—*(a)* Early in the year the manufacture of a cable was commenced for the Eastern Extension Telegraph Company to duplicate their Australian line between Penang and Port Darwin, which was to have been completed and laid during the month of November. An urgent necessity having arisen in the meantime for bringing the South African Colonies into telegraphic communication with the mother country, the Australian Governments readily consented to a part of this cable, then manufactured, being utilised for the purpose, and to a postponement of the completion of the duplicate line to Australia for three months. The whole line, 2,441 miles in length, has been successfully completed to Port Darwin since the end of the year. (*b*) In the month of April the Imperial Government, and the Crown agents, on behalf of the colonies of the Cape and Natal, authorised the Company to proceed with the line between Aden and Natal; one of the Company's ships was forthwith despatched with the first section of the cable, which being followed at intervals by four other vessels, the whole line of 3,845 miles was successfully laid within the year. The means for carrying out this great operation were provided through the co-operation of this Company and the Eastern Telegraph Company, with whose system South Africa was thus brought into direct communication. (*c*) In the month of February a concession was obtained from the Spanish Government, giving jointly to this Company and the Eastern Extension Telegraph Company the right to establish telegraphic communication between a point near Manilla, in the island of Luzon, and Hong Kong, which it is intended to carry out during the present year; the length of this line will be about 555 miles. (*d*) In May a contract was signed with the German-Norwegian Telegraph Company to make and lay a cable between Arendal, in Norway, and Hoyer, on the coast of Schleswig; this operation was completed in August, the length of the cable being 256 miles. (*e*) In the month of December a contract was entered into with the New Zealand Government for the manufacture, and laying in that colony, of 120 miles of cable, which is now on its way to New Zealand in one of the Company's ships. Other short lengths of cable have been made for various companies, bringing up the total length manufactured during the year to 6,917 miles. The factories at Wharf-road and East Greenwich, and the Company's steam ships are in

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thoroughly efficient working order. The retiring directors are Lord Alfred Paget and Mr. G. W. Campbell, who, being eligible, offer themselves for re-election.

ABSTRACT OF PATENTS.

1971. LIGHTING BY ELECTRICITY, *A. M. Clark.—Dated 16th May*, 1879.—*(A communication.)—(Not proceeded with.)* 8*d*.

A number of change lamps are combined for the production of each single electric light, so that if the first lamp is extinguished a second one is immediately substituted for the first, and a third for the second, a fourth for the third, and so on. The last lamp of the series may be replaced by an equivalent resistance, so that the whole of the lamps being out of working order will cause the extinction of this individual light only, without involving the extinction or modifying the intensity of the other lights in the same circuit.

1994. ELECTRIC BELL APPARATUS, *H. J. K. Bouchette and J. Aldridge.—Dated 20th May*, 1879.—*(Not proceeded with.)* 2*d*.

A round block of wood is attached to the wall, and on its front side is recessed to receive the magnet, the bell covering the recess. A stud is provided, by means of which the circuit is completed, so as to ring bells in other rooms, at the same time disconnecting the bell on the block, which is therefore silent.

2000. ELECTRIC LAMPS, *J. Cougnet.—Dated 20th May*, 1879.—*(Not proceeded with.)* 2*d*.

To a frame a metal tube is connected and contains a carbon which slides therein by means of a cord and weight. Upon the side of the tube is a magnet through which the current passes to the carbon, and above which is mounted an armature operating a stop-wheel, so as to allow the motion of the carbon. The negative pole consists of a hemispherical metal block which is placed over the carbon, and has inserted in its under side a piece of carbon.

2011. ELECTRO-MAGNETIC PENS, *J. M. Josias.—Dated 20th May*, 1879.—*(Complete.)* 6*d*.

This consists, first, in an electro-magnetic puncturing pen constructed with the puncturing needle, the electro-magnet, and the battery, so that they form one compact portable instrument, all the parts thereof being enclosed or shielded in a suitable case capable of being conveniently carried in the pocket or about one's person, and of being used anywhere like an ordinary writing pen; secondly, in the peculiar construction of a roller saturated with suitable ink or colour, and provided with an internal loose weight to press out the ink or colour for printing through the punctured plate or paper upon the required material.

2060. ELECTRIC LIGHTING, *A. F. Blandy.—Dated 23rd May*, 1879. 6*d*.

This consists in the application of an electro-magnetic governor for regulating currents of electricity in the branches of a divided circuit, so as to permit of Serrin or other voltaic arc lamps being used in the said branches.

2111. ELECTRIC LIGHTING APPARATUS, *W. R. Lake.—Dated 27th May*, 1879. *(A communication.)* 6*d*.

Revolving annular carbons are employed and are of considerable length, but occupy only a small space, thereby permitting a regular and continous light to be obtained for as long a time as may be desired without being renewed. The carbons revolve as the points between which the light is developed wear away, such points being thereby caused to remain continually at practically the same distance from each other.

2199. LIGHTING BY ELECTRICITY, *J. Furstenhagen.—Dated 3rd June*, 1879.—*(A communication.)—(Not proceeded with.)* 2*d*.

A round or prismatic carbon tube is employed, through which is placed a wick made of glass or other vitreous substance.

2211. TELEPHONES, *H. C. Dumontier.—Dated 4th June*, 1879.—*(Not proceeded with.)* 2*d*.

A horse-shoe magnet on one face receives a telephone and on the other a call consisting of a magneto-electric apparatus formed of two bobbins turning in front of the magnet. The current is collected by means of a commutator, and sent into any ordinary bell arrangement.

2267. ILLUMINATING BY ELECTRICITY. *G. Grout and R. Sennett.—Dated 9th June*, 1879. 2*d*.

This consists in increasing the illuminating power of the electric arc by passing through or around the electrodes gases or vapours rich in carbon or other substances in a fine state of division, by which means they become incandescent.

TRAFFIC RECEIPTS FOR JANUARY, 1880.

COMPANIES.	Jan. 1880.	Jan. 1879.	Incrse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	3,200 estd.	3,043	157	—
Direct Spanish Telegraph Company	—	—	—	—
Direct United States Telegraph Company	—	—	—	—
Eastern Telegraph Company	48,887	39,226	9,661	—
Eastern Extension Telegraph Company	28,009	24,695	3,314	—
Great Northern Telegraph Company	17,280	13,876	3,404	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—

TELEGRAPH SHARE LIST.

COMPANIES.	CLOSING PRICES FEB. 25.		BUSINESS DONE WEEK ENDING FEB. 25. Highest.	Lowest.
Anglo-American Ordinary	60,	⅛	61	59
Do. "B"	88⅜,	89¼	89¼	88⅛
Do. "A"	32½,	¾	33¼	30⅞
Brazilian	7⅞,	8	8 1-16	7⅞
Cuba	9,	⅛	9⅛	9⅛
Do. Ten per Cent. Preference	16½,	17	16½	16½
Direct Spanish	2,	⅛	—	—
Do. Ten per Cent. Preference	11⅝,	¾	11¾	11⅝
Direct United States	11½,	⅝	11½	11
Eastern	8 15-16,	9 1-16	9⅛	8⅞
Do. Six per Cent. Debenture	103,	106	—	—
Do. Five per Cent. do.	101,	103	—	—
Do. Six per Cent. Preference	12,	¼	12⅛	12
Eastern Extension	8 15-16,	9 1-16	9 3-16	8⅞
Do. Six per Cent. Deb.	105,	108	105¾	105¾
German Union	8½,	9	8⅞	8⅝
Globe Telegraph and Trust	5 9-16,	11-16	5¾	5⅝
Do. Six per Cent. Preference	11⅜,	⅛	11⅜	11⅜
Great Northern	9½,	⅝	9 7-16	9⅜
Indo-European	24,	26	25	24⅞
Mediterranean Extension	3,	⅛	3⅜	3⅜
Do. Eight per Cent. Preference	10¾,	11¼	—	—
Reuter's	11,	12	10⅞	10⅞
Submarine	240,	245	245	245
West India and Panama	1 15-16,	2 1-16	2⅛	1 15-16
Do. Six per Cent. Preference	7⅞,	8⅛	8	7 15-16
Western and Brazilian	7⅝,	7⅞	7⅞	7⅞
West. Union Seven per Ct. 1st Mt.	120,	125	—	—
Do. Six per Cent. Sterling	105,	107	—	—

ADDRESSES.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

PETER BROTHERHOOD, Engineer, 56 and 53, COMPTON-STREET, GOSWELL-ROAD, E.C.
Specialities—Patent 3-Cylinder Engines (Silver Medal, Paris), as used by Siemens, Gramme, and Wilde for driving Electric Machines.

RANSOMES, SIMS, and HEAD, Orwell Works, IPSWICH.
Specialities—Portable and Stationary Engines, fitted with patent governors, as tried in the electric lighting experiments on the Thames Embankment.

ABBOTT and Co., NEWARK-ON-TRENT.
Specialities—The "Standard Size" Vertical Cross Tube Boilers. Illustrated catalogue, giving every detail of a variety of Boilers, 2s. 6d., post free.

CARBON ELECTRODES COMPANY. Works: 39, COMMERCIAL-ROAD, EAST.
Specialities—Carbon Rods of all sizes for Electric Lighting. Also, Plates and all other Moulded Carbon Goods. List of prices on application.

M. THEILER & SONS, Telegraph Instrument Manufacturers, 86, CANONBURY-ROAD, N. Works: ALWYNE-LANE, N.
Specialities—Morses, Polarised Relays, Saunders' Curb Keys, Type Printers, Recording Sounders, Duplex Apparatus (Theiler's Patent).

HOOPER'S TELEGRAPH and INDIA RUBBER WORKS, MITCHAM and MILLWALL DOCKS.
Contractors for the Manufacture and Laying of Submarine Telegraph and Torpedo Cables. Manufacturers of Hooper's celebrated Insulated Core. Printed reports on application. Offices: 31, LOMBARD STREET, LONDON, E.C.

THE BRITISH ELECTRIC LIGHT COMPANY (Limited), 41, PARLIAMENT-STREET, WESTMINSTER, and 17, WATER-STREET, LIVERPOOL.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

ESTABLISHED 1851.

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The Bank undertakes for its Customers, free of charge, the custody of Deeds, Writings, and other Securities and Valuables; the collection of Bills of Exchange, Dividends, and Coupons; and the purchase and sale of Stocks and Shares.
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Southampton-buildings, Chancery-lane.

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A Pamphlet, with full particulars, on application.
FRANCIS RAVENSCROFT, Manager.
Southampton-buildings, Chancery-lane.

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SLIP

TELEPHONE EXCHANGES IN AUSTRALIA.—We understand that arrangements have been made to introduce this system of communication in Adelaide, and also in Melbourne.

A NEW CABLE.—The s.s. Calabria, belonging to the Telegraph Construction and Maintenance Company, sailed on Saturday, Feb. 28, with 511 miles of cable on board, to lay between Manilla and Hong Kong.

UNDERGROUND TELEGRAPHS.—Mr. David Brooks's system of insulating tubes filled with paraffin oil surrounding the conductor, is to be tried shortly between Paris and Versailles before a commission of French electrical engineers.

BARCELONA.—Arrangements are being made to try the Molera and Cebrian system of electric lighting in the large cotton mills of Messrs. Batllo and Batllo, of Barcelona. M. Cebrian is at present in Germany, superintending the construction of the apparatus, which is in a forward condition.

THE SOCIETY OF TELEGRAPH ENGINEERS.—At the next meeting to be held at the Institution of Civil Engineers, 25, Great George-street, Westminster, S.W., on Wednesday, March 10, 1880, a paper will be read on "Some Recent Improvements in Electric Light Apparatus," by Alexander Siemens, Associate.

PHOSPHORESCENCE OF THE GLOWWORM.—Electricity and the nervous fluid have both been invoked to account for the tiny lamps of the glowworm; but there is no Edisonian demon concealed therein, for M. Jousset de Belleune finds that the light is simply due to a general property of protoplasm which consists in the disengagement of phosphoretted hydrogen.

THE CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The number of messages passing over the lines of this company during the month of February was 2,889, estimated to produce £3,208, against 2,530 messages, producing £2,775 in the corresponding month of last year. The traffic receipts for the month of December, estimated at £3,000, realised £3,317.

THE BERLIN ELECTRIC RAILWAY.—Herr Werner Siemens has, we understand, made a formal application to the Berlin Town Council for permission to construct an electric viaduct railway according to his system, recently described in our pages, over some of the principal throughfares of the German capital. Every electrician will hope that the municipal authorities will grant his request.

PROFESSOR HENRY.—A memoir of the late Professor Henry, by the Anglo-American electrican, Mr. Frank L. Pope, Vice-President of the American Electrical Society, has been published by Messrs. Van Nostrand, New York. It is in the form of a pamphlet, and gives a clear account of Professor Henry's electro-magnetic investigations. Doubtless a larger biography of Professor Henry will appear in due course, but there is none as yet.

SIEMENS ELECTRIC LIGHT.—The management of the British Museum have decided to permanently adopt the Siemens electric light for lighting the great Reading Room. The lamps have been provided with a glass tray hung under them to catch any sparks of red-hot carbon that may fall and prevent them from dropping on any books or papers underneath. The old polyhedral glass shades are also being superseded by globes of frosted glass.

SHIP STRUCK BY LIGHTNING.—A Lloyd's telegram states that the "Varuna, Captain Scheen, from New Orleans, laden with oilcake, has arrived at Falmouth, with longboat stove, foretop-gallantmast gone, and foretopmast split; had jettisoned about 230 bags of cargo; vessel much strained and making water, having been struck by lightning during a hurricane on Feb. 17, which set the foretopmast on fire; had to cut away rigging and foretop-gallantmast to put out the fire."

A NEW DEPARTURE.—It is stated that Mr. T. A. Edison and Mr. Jesse H. Burnell are engaged in working out the problems of signalling between the lower levels of a mine and the engineer at the surface. "Mr. Edison is of opinion that they will be able to do all that is required." What a pity it is that this "new scheme" was not thought of years ago, for we fancy many of our mining electricians could give valuable hints, and, perhaps, say there was no need to work out any problem.

NAVIGATING TELEGRAPHS COMPANY.—A company has been formed in London, with offices at 142, Strand, for the purpose of working the electric steering and engine room telegraph. This invention has met with the approval of several well-known admirals. For example, Sir George St. Vincent King, K.C.B., says "It appears to me to be a most useful invention, and one long needed." Captain Woolcott, of the P. and O. steamer Pekin, says it is excellent and far surpasses the old system of coloured lamps.

THE MICROPHONE IN PHYSIOLOGY.—By far the best microphonic apparatus for studying muscular contractions under electric excitation which has yet been invented is that due to MM. Trouvé and Boyes, and illustrated in *Les Mondes* for February 5. It is free from the usual defects of these apparatus, and consists of a glass bell, enclosing the stretched muscle, which is hung from the arm of a small gallows, on the end of which is perched a very sensitive microphone. Mercury cups are used for the connections. The instrument is finely made by the ingenious M. Trouvé, of Paris.

FORMATION OF PERSULPHURIC ACID BY ELECTROLYSIS.—In 1878, M. Berthellot established the existence of a new acid of sulphur, persulphuric acid, $S^2 O^7$, and isolated it both in the anhydrous and crystalline state, by means of the electric spark, and in a state of solution by means of electrolysis. He has now succeeded in making it in larger quantities by the latter process, having obtained liquor containing 88 grammes of acid and more to the litre. He attains with difficulty, however, to the proportion of 123 grammes to the litre, and cannot surpass it, the rapidity of decomposition of the new acid under these conditions being equal to its formation.

A NEW COMPANY.—The Henley Telegraph Works Company (Limited), with a capital of £70,000, in shares of £100, has been formed to carry on the business of electricians, telegraph engineers, and contractors, cable and instrument manufacturers, wire-drawers, galvanisers, and wire-rope makers, producing light, heat, or power by electricity, galvanism, or magnetism, and to acquire the works of W. T. Henley, at North Woolwich, together with all machinery, plant, and appliances for the attainment of the foregoing purposes. The subscribers (who take one share each) are:—H. Alcock, 8, Drapers'-gardens; R. J. Jenkins, 16, King William-street; F. Newton, 16, King William-street; S. Gedge, Mitcham Hall; W. T. Henley, North Woolwich; J. D. Walker, Temple; A. Mongredien, 7, Copthall-court.

CHINA AND THE TELEGRAPH.—The Chinese Government (says the *Engineer*), through the efforts of his Excellency Li Hung Chang, have at length decided to establish a complete system of telegraphs throughout China—at least for

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the present in that part of China north of the Yang Tse Kiang. Mr. J. A. Betts is now on his way home to make arrangements for carrying out the work. It will be remembered that the Chinese Government have already a telegraph line from Tientsin to Taku, the stores for the construction of which were sent from this country, and which line was erected by Mr. Betts, with the students of the Imperial Torpedo College, Tientsin—the first successful telegraph line in China—and which may be considered to be the forerunner of the more important work about to be put in hand.

Interesting Electrical Experiment.—Mr. Levison, of New York, has made the following interesting experiments in electrolysis, which are suitable for projection on the screen by aid of a vertical lantern. He takes a cell having five short grooves cut in its bottom, so as to hold fine globules of mercury in a line, and the cell is then filled up with sulphuric acid. On touching the end globules with the terminal wires from a battery, they become almond-shaped, and the positive globule extends towards the negative pole, and the other four extend towards the positive pole. If the terminal wires be touched to the second and fourth globules, the second being positive extends towards the negative pole, the middle and fourth extend towards the positive pole, and the end globules, though not included in the circuit, extend towards the centre. This is an interesting example of Lipmann's effect.

Electro-deposition of Bismuth.—A series of experiments with various solutions of this metal has recently been carried out in the laboratory of Mr. D. G. FitzGerald at Brixton. Sesquioxide of bismuth dissolved in a hot solution of the double tartrate of soda and potash (Rochelle salt) was found to give excellent results at a temperature of about 160° Fah. The anode should be considerably larger than the cathode or article to be plated, and the electromotive force should be between one and two volts. A perfectly adherent deposit of silvery lustre, but of a darker colour than silver, and not liable to tarnish, may readily be obtained on iron or steel, copper and brass. Mr L. A. Davies, who, as pupil-assistant in the above laboratory, carried out most of the experiments in question, has, since he resigned that position, written to a contemporary to state that a solution of the ammonio-citrate of bismuth, as well as the solution above-mentioned, possesses all the practical requisites for the successful deposition of this metal.

Digney and Lartigues Railway Alarm Signal.—This invention consists of a steam whistle fixed on the engine, and worked by electricity. The whistle is connected with an insulated metallic brush, which is placed under or at the side of the engine. At the side of the line or between the rails there is a fixed metallic contact, about 7 feet long, faced with copper, which is in communication with the positive pole of a battery. The negative pole of the battery is in communication with a commutator on the signal post, from which a wire leads direct to earth. As long as the signal is at "line clear," the passage of the brush over the fixed contact produces no result, but when the signal is set to "danger" the commutator brings the negative pole of the battery in direct communication with earth, and, on the brush passing over, establishes a circuit, and causes the whistle to be sounded. The fixed contact can be fixed any required distance from the signal. This system obviates entirely the danger of running past the signals by reason of fogs, snow storms, or other causes, and has been adopted with perfect success by the Great Northern Railway of France.

Fire Alarms.—M. Brasseur claims for his fire alarm the advantage of being capable of working both when a fire spreads rapidly or slowly. The apparatus consists of two tubes of sheet zinc, both covered on the outside with lamp-black. They are attached in a vertical position to a cast-iron bedplate, their upper ends being separated by a copper plate, which, as a rule, is kept at a certain distance from a contact screw. This screw is connected with one pole of an electric battery, while the copper rod is connected with the other, an alarm bell being in the circuit. One of the two tubes is empty, while the other is filled with tallow, and is closed with sealingwax. As soon as a sudden increase of temperature takes place the empty tube will be heated more rapidly than the other, and in expanding will bend and bring the copper rod into contact with the screw, causing the bell to ring. But if the fire spreads slowly the heat will expand both tubes simultaneously until the temperature of melting tallow is reached. The tallow in the tube will become liquid, and therefore keep the latter from expanding as quickly as the empty tube, which in this case also begins to bend, and thus also rings the alarm.

Private Telegraph Wires.—On the 23rd February, in the House of Commons, Mr. Gray asked the Postmaster-General whether communications sent through private telegraph wires, rented to individuals by Government, were ever "tapped" *en route* by Government officials without the knowledge or consent of the parties to whom the wires were rented.—Lord John Manners: In answer to the hon. member, I have to say that all wires, whether public or private, are from time to time examined in order to see that they are in proper order, and that the work upon them is properly done. That examination takes place without any previous knowledge on the part of the renters or others interested.—Mr. Gray asked whether that involved a knowledge of the communications sent across the wires, so that these communications might be known by the officials of the Government without the knowledge of those renting the wires.—Lord J. Manners: Every telegram that is sent is stored after transmission at the Central Telegraph Office for the space of three months, in order that if any complaint is made, a telegram may be inspected. There is, therefore, no necessity for the course which is suggested.—Mr. Gray gave notice that he would put another question on the subject.

Telegraphic Communication.—A deputation appointed by the Associated Chambers of Commerce had an interview on Feb. 19 with Lord John Manners, the Postmaster-General, at the General Post Office, with regard to the postal and telegraphic arrangements recently agreed upon.—Mr. J. Whitwell, M.P., President of the Association, introduced the deputation, which comprised Mr. J. Behrens (Bradford), Mr. Donson (Derby), Mr. Blood and Mr. Wigham (Dublin), Mr. W. H. Wills (Bristol), Mr. Harding (Leeds), &c.—Mr. J. Whitwell read a memoral, setting forth that they thankfully acknowledged the improvements adopted by the St. Petersburg Telegraphic Conference, but wished to ask for certain other improvements. They regretted the prohibition of the the use of the proper names of persons and places in any other than the natural sense, which caused great inconvenience to those who were in the habit of using a certain code under the old system. They hoped that this regulation would not be insisted upon. They asked that the "word" system which had been so long in use in foreign countries should be adopted, and also that permission should be given to use figures in telegrams instead of being compelled, as at present, to put figures into words, and they asked that five figures should be counted as one word.—Lord John Manners

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said England had no power whatever to vary in the slightest degree the conclusions regarding external telegrams which were arrived at by the Postal Telegraphic Conference. No alteration could take place except with the consent of every one of the contracting Powers. He need not point out to them the immense difficulty of changing that which the contracting Powers came to only a few months ago. All the great Powers were present, and even Japan had representatives there. He was afraid that he could not hold out any practical hope of any immediate consideration on points relating to external telegrams. He would rather recommend them to ascertain how the system worked, and prepare the information for the consideration of the next Conference. With regard to the other points, he would bear them in mind and give them full consideration.

Electricity v. Gas.—At the tenth annual meeting of the Manchester District of Gas Engineers, held last week, Mr. Chew, of Blackpool, read a paper on "Three Months' Experience of the Working of the Electric Light." He described the experience with, and the result of the practical trial of, the new illuminating power as a means of lighting up the Blackpool promenade and piers, then entered at some length into the question of cost, and stated "that the capital expended in the case of Blackpool was £2,800. The working expenses were £3 6s. 10d. per night of five hours. With respect to the question of electric lighting in general, he entertained no fear that it would ever supersede gas, pointing amongst other things to the difficulty which must inevitably be occasioned, if gas were used as a general illuminating power, by the fact that electricity could not be stored, but must be produced as required; so that the apparatus would have to be continuously at work for the benefit of consumers who might require light during the day or night. He also referred to the difficulty of increasing the number of lights beyond a certain number in one circuit, so that small lights could not be produced as economically as large ones. He saw no cause for alarm, for he was sure that electricity, with its delicate automatic cut-off arrangements, which would soon get out of order, would never be used for the illumination of dwelling-houses and such-like purposes, though for lighting public squares, large halls, &c., it might enter into competition with gas. In the discussion which followed, the ex-president (Mr. Newbiggin) expressed his opinion that electricity was simply an expensive luxury in lighting. Several members spoke of the failure, or comparative failure, of experiments which they had witnessed, and the President referred at some length to an experiment made in illuminating a combing shed in Messrs. Crossley and Sons' woollen mills, Halifax, by means of the "Brush" light. Sixteen lights, with a total illuminating power equal to 2,000 candles, were in use, all supplied on one circuit by one machine of 14 horse-power. The light was steady, and was not affected as regards the other lamps by the accidental extinguishing of one or more of the number. The capital outlay was equal to a fixed annual charge of £75, to which £25 must be added for attendance. The cost of the 16 lights was 1s. 3¼d. per hour, and they displaced 200 gas burners, consuming 1,000ft. of gas, costing 3s. per hour. Calculating upon the average number of hours that a mill was lit up in a year the cost of the electric light would be £19, in addition to the fixed charges of £100, or a total of £119, while the gas would cost only £45." Some of the information given this week in other columns will cause readers to doubt the value of these expressions of opinion.

The Electric Light at Albion Mills.—The electric light is now in practical work at Albion Mills. It is supplied by the Anglo-American Electric Light Company (Limited), Hatton-garden, London; and on Thursday night, and again last night, their engineer exhibited the light, by the kind permission of Messrs. John Crossley and Sons (Limited), to a number of visitors. The devotion of Mr. L. J. Crossley to electrical science is too well known to need mention here, and the public are, no doubt, indebted to him for this opportunity of seeing the light in practical work. Messrs. Crossley, we understand, have adopted the system on trial. It is applied only to the carding and combing shed, a building with an area of 200 feet by 135, and hitherto lit by 230 gas jets. The light is generated by a "Brush" dynamo-electric machine (so called from the name of the inventor), and there are 17 lamps (any one of which can be extinguished without regard to the rest) in a single circuit. The circuit of the lamps, too, can be extended to any length up to 10 or 12 miles from the machine—an important consideration where one machine and engine are to be used for several buildings or rooms a long way apart. By a regulating attachment to the machine, any less number of lights than the maximum can be used, absorbing proportionately less power. Each light is in a globe, the lower part of which is transparent, and the upper part semi-transparent. Fifteen lamps were used on Thursday night, taking the place of the 230 gas lights. The effect was very fine indeed. The light was steady as that from gas, with the exception of that from two lamps, which was a very little unsteady. The arrangement of the lamps, hung perhaps three yards from the floor, caused the light to be equally diffused over the place. The writer asked a workman for his "honest" opinion about the light. The workman said he liked it much better than gas, first because it enabled him to see work better which required his close attention, and, secondly, because there was no gloom in any part of the shed. Some of Messrs. Crossley's carpets were shown in order that the effect on colours might be noticed. It is easy to distinguish any colour by the electric light. An adjoining shed was lit with gas, and as both sheds could be seen at once, the superiority of the electric light needed no further demonstration. Halifax gas, good as it is, appeared a dingy, tawdry yellow. But the merits of the light itself are well known; what the public wish to know is something about the cost. On this point we have made inquiries, and are able to lay before our readers some facts, obtained from an impartial source, which have the merit of being compiled cautiously in the buyer's interest. To light the shed at Albion Mills with gas, 1,265 feet are consumed per hour, the cost being about 3s. 11d. This does not include gas fittings and repairs. The first cost of electric lighting is rather serious. Including all plant, it has been, in Messrs. Crossley's case, about £660. To arrive at the working cost, a cautious manufacturer would reckon on this 5 per cent. interest, 5 per cent. depreciation, and 2 per cent. for wear and tear. The machine requires 14 indicated horse-power to work it. The carbons, which are consumed by each lamp at the rate of 2 inches an hour, cost 4d. per foot. The only additional outlay is for labour, and in Messrs. Crossley's case a man will probably be employed not more than half an hour a day. Here, then, is the basis of a calculation which each can make for himself. The figures point to this general result, that where a large area is to be lit, and where the number of hours during which the light will be required per year is considerable, the cost is much less than that of gas. Where gas is used in small quantities it will, for the present, be the cheaper means of lighting, but this leaves out of question the much greater illuminating power of electricity.—*Halifax Courier.*

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CORRESPONDENCE.

AN INTERNATIONAL NUMERICAL CODE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Now that code signalling is so much in vogue, may I be permitted to suggest that a revision of the Morse numerals should be made so that a code number composed of comparatively few signals might be sent instead of a code word. The signals I would suggest are based upon the Roman numerals, and are as follow:—

1	I -	6	IV —— -
2	II - -	7	VII —— - -
3	III - - -	8	VIII —— - - -
4	IV - ——	9	IX - —— ——
5	V ——	0	—— ——

The advantage of code numbers is that whereas a number is intelligible to people of all nations, a code word is often anything but intelligible.

There is no reason why some international system of telegraphing by means of numbers should not be established. The words of a language might be arranged in their order of simplicity, and a distinct number might be assigned to each. If this vocabulary were to be translated into every language, the same number would stand for the same idea in every language.

Of course, a telegram sent in numerals representing an English sentence would be received as an English sentence, but the receiver, if he happened to be a foreigner, would refer to his vocabulary for the meaning of any of the words he could not understand in the English sentence.—Yours, &c.,

CHARLES STEWART, M.A.

50, Colebrooke-row, N., 2nd March, 1830.

THE ESSENTIAL NATURE OF ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your correspondent, "Ignoramus" (whose *nom de plume*, by the way, does not harmonise with his communication), writes under the misapprehension that he is "demolishing" me, amongst others, whilst in reality he is supporting, in some measure, my view that "Electricity, in whatever sense the term may be used, cannot be regarded either as a 'force,' an 'affection of matter,' a 'mode of motion,' or a 'form of energy;'" but that "it has a substantive existence as a physical entity."* Whilst fully agreeing with him in his conclusion that "electricity is of the same dimensions as that which we call 'matter.'"—a conclusion which I cannot quite reconcile with the accompanying statement that q "is certainly not in the same category as matter"—I am unable to follow him in all his applications of the dimensions derived from the laws of accelerated motion. These "dimensions," I think, require to be used with very great caution in the domain of electrostatics, or in cases of uniform motion. Moreover, the acceptance by "Ignoramus" of the "law of inverse squares," which I regard as a delusion and a snare, vitiates to my mind certain of his conclusions.—Yours, &c.,

DESMOND G. FITZGERALD.

THE MATERIAL NATURE OF ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Sympathising as I do with Mr. FitzGerald's contention, from a common sense point of view, I much regret to have utterly lost sight of that gentleman in a vast fog of mathematical abstractions.

It is now several weeks since he departed from this common life; and I hope he is right, because there are a few Clerk-Maxwell's spirits closely watching his ærial flight, who would gladly make a serious *Lodge*ment in his fragile Carr.

Of Mr. FitzGerald I know nothing, but for his antagonist I feel a most lively friendship, and am sure he will not take it amiss if I presume to animadvert on the weakness of his opposition.

The fog which I have charged upon Mr. FitzGerald might require some qualification, because it may be a dense mystiness, constituted of my ignorance, of abstract and scholastic methods, above and beyond which the atmosphere may present a clear and bracing serenity.

But there is a fogginess of another category, where Messrs. Sprague and Gordon are making ludicrous efforts to feel their way.

Prof. Gordon has explained to a London Institution audience that a duality of *force* may be put into a Leyden jar, one part of which can freely go through the glass, while the other cannot, just as Mr. Sprague tries to make believe that one *convertible* part of his strange duality can freely go through glass or air, and be represented by $\frac{E^2}{R}$; while the other is *inconvertible*, and is definitely represented by $\frac{E}{R}$.

Many will admit that Mr. Sprague has won a high position by his clear elucidation of the first formula, and while clear as a bell as to the practical facts, or mathematical relations of the second, it yet follows that he may be very wide of the mark as to any clear view of the physical *modus operandi*.

I greatly admire the fairness and clearness of his fundamental admissions:—to wit, that there is

1st. An apparent transfer of "a quantity" (be it what it may) or current $C = \frac{E}{R}$ perfectly analogous to the pint, pound, or cubic foot of water.

2nd. A transfer and expenditure of energy $\frac{E^2}{R}$ perfectly analogous to that transferred and expended by a current of water.

3rd. A something called tension, measured as difference of potential, also perfectly analogous in the two cases.

Then come three other statements or definitions *per contra*, which are held to be inconsistent with the conception of E as a matter or fluid.

I do not accept these definitions as either clear or correct in themselves; but, admitting them for argument's sake, it then follows that the sole substance and bearing of the conclusion is that the two currents are not identical in all particulars, and, therefore, if one be material the other is not!

In one case we have a motion of mass, a direct linear current; in the other we have a motion of atoms, whether linear, spiral, or otherwise may not be known, nor is it necessary in order to establish the common fact that both obey the same mechanical laws—to wit, that the current is *directly* as the potential, and *inversely* as the sum of the opposing resistances; and, further, that in both cases a doubled potential implies the expenditure of fourfold energy.

The whole secret of the matter is that Mr. Sprague is afflicted with an occult theory to explain the anomaly I have referred to, where Prof. Gordon is more wisely reticent. Mr. FitzGerald is like Prof. Tyndall with matter (or an unknown something) *and* its properties; whereas Mr. Sprague substitutes the former by "an agency" which possesses the *inconvertible* and other properties required, and an "energy" or work varying as the square of its ratio of motion.

Mr. Sprague has thought much of this "agency," and gives three diagramatic drawings of its character, which are fatally and absurdly invalid.

Some such representations have often been made, with more or less of congruity, to represent the changes of magnetism in a bar of iron or other material, where there is no absolute transfer of material in a continuous current.

His needles may move round their centres, now attracted by northness, and then by southness, but like the circles or diagonals, it is only a change of polarity; whereas current is *actually current*, in the sense that something analogous to a grain of water is really transmitted.

The wire complication may be a great difficulty, and the little understood mechanism of atomic motion another; but the main facts are plain, and if we insert imaginary, or infinitesmal voltameters and calorimeters in the circuit at London, New York, or in the middle of the ocean distance, the same inevitable result must always take place, viz., that every unit of current will be registered in one, and its four-fold energy in the other; nor can one unit of either E or E^2 subsist in any part without its *causal* relation to the pole, end, or point of transfer and decomposition, where the electromotive force originates.

This is not all, for, besides testing this current in any part quantitatively, we may do so qualitatively so as to find out the nature of the material thus transmitted.

A voltameter is to the plating technologist a decomposing cell, and so is a Bain printing insertion; the paper is a kind of non-conducting porous pot or sheet, so that the current must needs pass through the liquid held between the pores. The binary action is such that metal is projected on one side, and the unknown E on the other. If the sending current be from the zinc pole, then it is immaterial whether the metal end be copper or iron, as no metal is liberated from that side; but, on the other side the metal spring resting on the moist paper should be of iron, because the copper salt formed would have but little colouring power, whereas the atom of iron projected upon the gallotannic or other liquid forms a visible black ink signal.

I could say much more as to the negative and material character of the unknown E; but I prefer to leave this in good hands, and hope that Mr. FitzGerald will fairly elucidiate the problem.

SAMUEL E. PHILLIPS.

* *The Electrician*, Nov. 22, 1879, p. 9.

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THE TELEGRAPHS OF THE GERMAN EMPIRE FROM 1876 to 1879.*

(CONCLUDED FROM PAGE 137).

RE-ARRANGEMENT OF THE CENTRAL STATION AT BERLIN.

The former main hall devoted to apparatus at the Berlin central station being found inadequate for the requirements of the extended telegraphic service, partitions had to be put up, which were found to be of detriment to this service. Moreover, the location on the fourth floor of the central building for posts and telegraphs was most unfavourable. Besides the trouble of conveying to the fourth floor the telegrams delivered on the ground floor, and the inconvenience of the daily circulation of several hundred *employés*, the danger of this situation in case of fire was a consideration sufficient to necessitate a prompt alteration in the arrangements.

Under these circumstances, the Administration decided to occupy an adjoining building, which allowed them to transfer to the ground floor the entire technical service of the central station, and to arrange over 300 apparatus in a hall 42½ by 20½ metres in dimension.

The installation of the apparatus in the new hall took place on Nov. 19, 1878. The lines terminating at this station were 254; and 64 cables having 7, 4 or 3 conductors, as well as some cables with a single conductor, were used to lead them into the building. Out of these 254 lines, 28 belonged to the great subterranean lines. The others, those at least which traverse Berlin, are overhead lines, of which 31 serve for the direct communication between Berlin and the principal foreign towns, 34 for correspondence with the principal exchanges and commercial centres in Germany, 26 for correspondence with towns of less importance, and 21 for correspondence with small localities in the country. The remaining lines connect the offices in Berlin and its suburbs with the central station of the telegraphs.

III.—APPARATUS AND TECHNICAL SERVICE.—NUMBER OF APPARATUS.

We have already seen that the variety of systems of apparatus employed by the German Administration has been extended by the introduction of the telephone in the service of the stations. The following, according to the report, are the numbers of apparatus and battery cells used during the three years from 1876 to 1878 :—

	1876.	1877.	1878.
Morse apparatus	5,173...	6,099...	6,992
Hughes ditto	102...	128...	151
Telephones	—	48...	981
Apparatus belonging to other systems	13...	11...	4
Total number of apparatus	5,228...	6,286...	8,128
Number of battery cells	79,501...	91,123...	105,582

The report supplies also the following information relative to the technical work in connection with the telegraphs during the same period.

TECHNICAL SERVICE.

The introduction of subterraneous lines of telegraph, the invention of the telephone, and the application of other discoveries in relation to telegraphy, have greatly enlarged the domain of technical telegraphy. In spite of this extension, the service of telegraph stations, harmonised with the corresponding arrangements of the postal organisation, has become more and more simplified, without detriment to the certainty and rapidity of the communications.

The electrical condition of the subterraneous lines is ascertained by regular and minute tests with the reflecting galvanometer, since an accurate knowledge of the state of the lines is of the utmost importance to the telegraphic service. The transmission through these lines is facilitated and assured, in the case of long distances, by means of the Hughes relay.

Careful experiments have been made on the different methods of diplex and duplex transmission, as well as with new apparatus, such as the *key-board* apparatus of Siemens (Siemens-Dosenschreiber), the multiple apparatus of Meyer, &c. The question as to the use of these apparatus in the telegraphic service is at present under consideration.

A requirement that has often been felt in practice has been met by the adoption of arrangements of which one allows of stations in circuits worked by interruption of the current being placed directly in communication with stations worked by completing the circuit; whilst the other gives to stations on the main lines the means of communicating directly with stations forming the terminals of branch lines.

The publication of a description of the apparatus used by the Administration, together with illustrative plates, supplies to the telegraph *employés* a guide in relation to the arrangements and mode of working of the apparatus, and to the manufacturers precise indications for their construction.

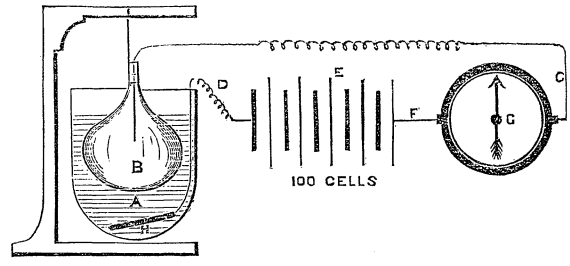
The postal and telegraph services having been combined, the instructions for the service of the telegraph have been included in the "Regulations for the General Service of the Posts and Telegraphs," and the special "Regulations" for the telegraphic service have been suppressed.

The map of the telegraph lines was re-edited in 1877, partly on account of the changes which had occurred in the division of the telegraphic circumscriptions in consequence of the fusion of the posts and telegraphs, and partly by reason of the extension of the system. In view of the creation of a subterranean system of some extent, and of the increase of overhead lines in latter years, the necessity for a fresh edition of this map has been urgently felt. The work in relation to this has already been undertaken by the central office of the telegraph, and it will be carried into effect as soon as possible.

* Translated from the *Journal Télégraphique*.

AN EXPERIMENT ON INDUCTION.

At the last meeting of the Society of Telegraph Engineers, during the discussion of Mr. C. H. Wilson's paper "On Induction in Parallel Circuits," Mr. Willoughby Smith described a very interesting experiment he had made with a bladder of gutta percha, which well illustrated the electrical and other qualities of that material. In an inverted glass shade, A, containing clear water, was suspended a bladder of gutta percha, B, filled with water; through the neck of the bladder was a copper wire, C, which was in contact with the water in the bladder. A copper plate, H, was immersed in the water in the glass vessel, and a wire, D, connected with it was attached to one pole of 100 Menotti battery cells, E. Another wire, F, from the other pole of the battery was connected to one terminal of an astatic mirror reflecting



galvanometer, G, the other end of the galvanometer being connected to the wire C passing through the neck of the bladder. The superficial area of the bladder immersed was 203·6 square inches, its thickness ·00065 of an inch, and its total weight 32 grains. The bladder contained 12lb. 14oz. of water, and had been suspended in air for eight days before it was immersed. The absolute electrical resistance of the 203·6 square inches was 1487·6 megohms at the end of one minute's electrification, and of ten minutes it was 4103·8 megohms. The absolute electrostatic capacity was ·2266 microfarads. Its behaviour during the test was precisely the same as that of copper conductors insulated with gutta percha for telegraphic purposes when similarly placed. Mr. Smith is continuing the experiments with the view of determining a true unit for the electrical properties of gutta percha.

ABSTRACT OF PATENTS.

2301. ELECTRIC LIGHTING, *R. Werdermann.—Dated 10th June*, 1879. 6*d*.

The upper electrode is secured by a clamp connected to an arm placed in a horizontal position, and pivotted to a sliding piece on a fixed vertical bar. In order to diffuse the light more effectually, an opal disc is placed under the light, and a portion of the rays pass through it, and are reflected upward upon a broad deflector fixed above the electrodes.

2322. ELECTRIC LAMPS, *C. D. Abel.—Dated 11th June*, 1879.—(*A communication.*)—(*Not proceeded with.*) 2*d*.

The two carbon electrodes are carried by two pistons, plungers, or floats contained in two closed vessels filled with liquid, in communication with each other, the relative heights of the liquid in the vessels and the weight of the pistons and arms projecting therefrom carrying the carbons being so proportioned that the piston carrying the upper carbon will tend to descend in its vessel, causing the liquid to flow therefrom into the other vessel, and thereby raising the second piston with the lower carbon.

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THE ELECTRICIAN.

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JULIUS BEER.

With deep regret, we have to announce the death, at the early age of forty-three, of the Proprietor of this Journal. Mr. Julius Beer, who had for some time been in ill-health, succumbed to an attack of apoplexy, at Mentone, on the 29th ult. To those who have taken a part in the rapid developments of submarine telegraphy, or even to those who have merely taken an interest in them from a commercial point of view, we need scarcely say that Mr. Beer had taken an undisputed position of eminence, as a capitalist in whose judgment and cultured intelligence the greatest confidence was deservedly placed. Though his name is not one of those which have obtained the greatest outside prominence in connection with the financial management of some of those gigantic enterprises of which the success has been due to an exceptional combination of ability and working power, it was assuredly one of those held in the greatest esteem by his co-workers. Of our own relations with him we shall always bear the kindliest recollection; we can say that the aid of his judgment was always forthcoming at need, though he never sought to influence the free opinion and conclusions of those whom he had placed at the helm of one of his smallest literary ventures. And this well-deserved praise, which an Editor may give without impertinence, since he is in the best position to appreciate the public benefit involved in it, will, we are sure, be forthcoming from other directions. The death of such a man is a loss that will be far-felt; and we ourselves are in a position to judge how difficult it would be to replace him.

SEISMOLOGY.

It is a characteristic of one of our best known novelists that her titles are selected for their curtness and vagueness. The casual reader draws no inspiration from the title, because it does not, and is not intended to indicate the contents of the work. The title of this article we make bold to say conveys as much to the mind of the average reader as does that of one of the novels of the authoress to whom we have alluded. What is Seismology? and what has Seismology to do with electrical matters? Seismology is the term introduced, we believe, by Mr. R. Mallet, F.R.S., to do duty for the phrase "the science of earthquakes." This science is one in which the inductive method of research is peculiarly suited. Masses of facts are to be obtained and compared. Then it may be possible to attempt to deduce laws, and to ascertain by future observance whether such laws accord with the phenomena. Mr. Mallet's investigations were exhaustive, his reports are and will remain the classics of our literature on the subject. In his experiments he made use of electrical apparatus to determine the exact time of certain portions of the experiments. But Professor Hughes has, within the past two years, placed in the hands of the scientific expert an instrument of the utmost delicacy. The microphone and its varied modifications is being adapted to scientific research on every hand. The *Japan Gazette* of December 13 contains a long article describing the application of this instrument to seismological investigations. This, then, is more particularly the reason why we draw the attention of our readers to the matter. Many reside in parts of the earth where earthquakes are by no means infrequent, and knowing that "facts" are required may be an incentive for them to construct the simple apparatus, and, as opportunity offers, to add the results obtained to the general treasury. For some years past we have noticed our contemporary, *Nature*, endeavouring to keep a record of earthquakes, and no doubt a simple statement of the facts observed in each case would be far more welcome than the mere statement that an earthquake has occurred in this or that country. What are the motions of an earthquake? What is the extent of these motions, the duration, the time, the destructive effect, what the angle of the cracks, the broken shafts of pillars with the horizontal? What conditions obtain before and after the shock? These are some of the questions which everyone might try to answer. The observer at Tokio, describing the earthquake of December 3, says:—To confirm my present observations, which have given me two curves of approximately true earthquake motion, and to be able to state definitely what these actual motions are, I am now anxiously waiting for about three more good shakes. One feels as anxious as a fisherman who is waiting for his float to bob. Earthquakes, no doubt, are very alarming, and when they shake down chimneys they are very likely to be regarded as dangerous and unpleasant visitors. If, however, you could only persuade all your friends to go in for seismographs, I think they would derive from them a pleasure never anticipated. Those who lost their chimneys would, when they reflected upon the advantages which accrue to science when the nature of the movement that caused the fall of the chimneys has been studied, wish they had twenty more chimneys in readiness for an immediate repetition of the shock. Besides endeavouring to obtain the true motion of any earth particle, I have, for special reasons, been endeavouring to obtain records of the smaller shakings. By the use of a special form of microphone when it is properly placed it is not difficult to detect any movement, however slight, of the earth's crust. My microphones are buried in pits round about the house. Precautions have been taken to keep out insects, otherwise the tramping of a beetle would register as an earthquake. The pits must also be dug at a distance from the roadway or path, otherwise every step of persons passing, even if six yards distant, will be indicated

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to the recorder. If several microphones were placed round about a house, not only would they be useful as seismographs, but they would indicate the creeping of an approaching thief; and lying in bed with a telephone to your ear you might count the number of steps as he approached towards your bed room window. His hesitation would be indicated in the pauses between the steps, and you might thus have a basis upon which to speculate as to the temperament of your visitor. Excluding beetles, thieves, and unexpected visitors, it would seem that for some time before the occurrence of a "shock" the telephone gives signs that the earth is crackling as if under an increasing strain; these indications continue for uncertain periods, but they have been distinctly noticeable before the last few earthquakes. It would seem that the power of resistance of the earth before any surface movement is felt is very great, but, at last, like a bending stick, it suddenly breaks, and the jar gives the vibrations which we call an earthquake. If these "crackles" can be detected we shall then have the means of approximately foretelling when the consequent crash is at hand. This, I think, has already been roughly indicated, but before making positive statements on this subject my present observations must be verified by repetitions. The observations of these "crackles," which, so far as I am aware, have hitherto been studiously avoided or else unfortunately neglected, would also tell us something definite about periodicity. From my observations I feel certain that there are many small earthquakes which ordinary instruments pass by unnoticed. The consequence is that, when we attempt to correlate earth motions with those of, say for instance, the moon, we do not find the accordance we should expect; the attraction of the moon has not been sufficiently great to overcome the elasticity of the earth's crust, and to cause shocks great enough to be recorded upon the usual instruments. If, however, instruments still more delicate are used, we shall find little earthquakes, or what I prefer to call earth tremors, recorded in those places where we have been unsuccessfully looking for big ones. We shall, in fact, detect the little straws which are being piled up in regular order and which will eventually break the camel's back.

Since the above was written another earthquake has occurred, and we shall watch with some interest the information which will doubtless soon come to hand, but much more so the results obtained by the use of the new apparatus. Might we suggest that those experimentalists in Japan who "threaten to move the scientific centre of the world" might have automatic seismic-electric instruments at Yokohama and Tokio, so that the exact time of the action and the velocity of the movement in particular geological formations might be known.

A PROBATIONER'S EXPERIENCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I read the letter of "W. H. A." in your issue of the 14th February, with reference to the course of training undergone by probationers for the Eastern Telegraph Company's service at Porthcurnow, with much interest; and as I myself have served a probationship there not a thousand years ago, I think it may be of some interest to your younger readers, and may serve to strengthen the remarks of your correspondent, if I relate my experiences as a probationer at P.K. Now, Sir, method is good in all things, and, as business comes, or should come, before pleasure, I propose to give a sketch of a probationer's work *ab initio*. I will do my best to make the story short, though I have a good deal to say.

Let us suppose the probationer to have arrived. He is, as Mr. A. has said, after learning the alphabet, set to work on an old Morse slip, and a nice jumble he generally makes of it. However, if he be but ordinarily intelligent, and with a little help from the clerk in charge of the practice room, he soon comes to be able to read fairly well, though slowly. Constant practice in a few weeks enables him to read at a good pace, and he will probably have learnt to send pretty well also. He then is put to the Recorder slip. Now, this generally gives fainthearted ones a mild sort of shock, the signals appear to be so many unintelligible erratic wavy lines, out of which he cannot make either beginning or ending; even after he has had a word or two translated for him he is powerless to make a single letter out for himself. Presently, however, he begins to be able to distinguish a letter or so, and then, perhaps, a word here and there. Now he is fairly started, and if he be persevering will soon master what was so much double Dutch a week or two ago. And here I may perhaps be permitted to remark that what proves of almost more value to the probationer than natural quickness is patience and perseverance. *Nil desperandum* invariably gets him on at a pace which astonishes him; for in telegraphy there is nothing to guide him as to what the signs or signals mean; he has never seen them before, they are a totally new alphabet to him, and he is as helpless as a child learning his A B C; and, therefore, as Mr. A. rightly says, it is best for clerks to learn when yet quite young. As to a young fellow verging on manhood or to a man, there is something almost intolerable in having to begin his education absolutely all over again; though I do not think these latter are exactly the sort to become good clerks, for if they feel it intolerable, this shows a lack of the patience and perseverance which, as I have said, I believe to be absolutely indispensable to telegraphists.

During this time, however, his scientific education has not been neglected, he has attended the first course of lectures, and has been grounded in the elements of electric science, and should begin to feel an interest in it, quite apart from the mere practical work; he has found, too, that neat writing and good spelling are highly thought of, and has, or ought to have, done his best to perfect himself in this. About this period he begins to have visions of the day when he will be placed in the "duty list" for checking work in the instrument room, and looks forward to a break in his eight hours' practice work. In the meantime he has gone a step further, and is now dividing his practice between Morse and Recorder and Mirror work. The Mirror will probably exercise him a good deal at first, as he finds great difficulty in distinguishing the flashes, and he may find that it will make his eyes ache a little at first. By degrees, however, this wears off, and he begins to read the signals, slowly at first, better and better every day. Then, also, he makes his *début* as a sender, and finds himself more interested than he could have imagined possible in being able to send at a good pace, and yet keep his signals nicely spaced, so as to be easily read. The keys used for the Mirror are the same as those used for the Recorder, and sending is very much like playing two notes of a piano with the first and third fingers. I believe that happening to be able to play on the piano greatly helped me in being able to send fast and clearly on the Mirror keys. I may notice here that one very frequent stumbling block to a learner is the vibration of the Mirror, caused by persons moving about the room, which causes the light to shake, thus adding to his difficulty in distinguishing the signals. A little practice, however, soon gets over this.

And now comes a great era in his career. The probationer, having shown himself persevering and careful, and having arrived at a stage when he can read Morse and Recorder tolerably well, finds himself considerably higher up the third grade, *i.e.*, the "probation grade," than when he began, and presently finds himself noted for four hours' duty in the instrument room as check or abstract clerk, and here may be said to begin his life as a telegraphist.

Let us suppose he has taken his place as "check" at Recorder or Morse. Should the signals be good, he manages pretty well, but presently he comes to some faulty ones, which the clerk at the instrument has been able to read by reason of his experience, but which the "check" cannot for a long time decipher. Now, whilst he is stopping over this, messages keep on coming, the slip in front of him keeps on accumulating, and when, perhaps, with the aid of the older clerk, he has got over the difficulty, he finds himself a long way behind, and now comes the time to show his patience. He must not be in too much of a hurry, or he will make mistakes; and, maybe, a message or two will be returned to him, in which, after being compared with the older clerk's reading of them, some mistakes have been found, and he will have to look back along the slip to find them out. This will put him still more in arrear. After four hours of this he will doubtless feel dissatisfied with himself, but the *nil desperandum* portion of him will take courage, and the next day will find him quite

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ready to tackle the work again with a little fund of experience to fall back upon. A few days more and he finds himself in the second grade, with only an occasional return to the practice-room for Mirror work.

And here I had better explain, that the office work is divided into three "duties," of eight hours each, viz :—8 a.m. to 4 p.m., or morning duty; 4 p.m. to 12 p.m., or evening duty; and 12 p.m. to 8 a.m., or night duty; on Sundays, however, the morning and evening duties are again subdivided, each duty being only four hours.

Up to this point the probationer has probably only been on morning duty. Now, however, he goes a step further, and has a week's evening and morning duty alternately, and as no practice goes on in the evening he begins to feel himself less of a probationer and more of the clerk. Now, too, he will have advanced into a higher series of lectures, he will be asked to send in plans of various kinds of circuits, and diagrams of batteries joined up in different ways. This is really interesting work, and as the care and neatness with which the drawings are made are thought a great deal of by the lecturer who has set the work, the probationer who is in earnest will use his best endeavours to make them neat, and will meet with his reward in the shape of the lecturer's commendation. This drawing of the various circuits will impress the different connections, &c., on his mind far better than as if he merely followed out text-book explanations of a printed diagram, and will probably urge him to endeavour to establish with a fellow probationer a little circuit of their own between their two bed rooms. Now, if they succeed in doing this correctly, what an amount of experience have they gained—worth volumes of reading or lecturing. In my time two probationers did construct a circuit of this sort, and carried out no end of little experiments on their own account; no mere machines these, Sir, but the materiel for first rate telegraphists. Probationers like these were sure to attract the attention of the superintendent, who, as I can testify, would in every way in his power, by answering questions and otherwise, aid them in their endeavours. But to return to the practical part of the business.

Now, on evening duty, he will be enabled, if he has the least wish to get on, to take a turn at sending, either Morse or Recorder, under the supervision of the clerk in charge of the instrument, who will look after him and give him a hint or two as to the best way to go to work; and this is, I believe, the time when a probationer may, if he chooses, get along like a house on fire, for if he prove himself ordinarily quick the clerk will be only too glad to let him do a little of his work; and if he does it well, and shows aptitude, the probabilities are that the instrument clerk will mention it to the C.C., who in turn will report to the superintendent, the result being that the probationer will find himself in the first grade, with probably four hours' duty, receiving or sending; or, perhaps, he may be placed in charge of the Vigo circuit, this being not quite such a difficult one to work as the others. Now, too, he will find himself taking his turn for night duty as abstract clerk, and begin to realise that he is becoming of use. On night duty the same opportunities for making himself still better acquainted with the work of taking charge of a circuit will be afforded as in evening duty, and if he makes the most of them, the inevitable result will be still further promotion, until he at length finds himself close to the goal at which he has been aiming, *i.e.*, he will see his name registered among the first in the first grade, and, therefore, liable at any time to be sent abroad and begin actual service.

About this time his duties will, probably, be divided somewhat as follows:—First week, morning duty, four hours Recorder receiving, four hours Morse ditto; or in charge of Vigo circuit; or, perhaps, four hours Mirror practice in place of Morse or Recorder receiving. Second week, evening duty, same as morning without the Mirror practice; or, perhaps, he may be ordered to examine the check messages with the originals, and see that the checker corrects his errors, which he will have to enter in in a book kept for the purpose against the checker's name, and in which, by the bye, all errors committed by clerks are entered, and at stated times added up and forwarded to headquarters, from whence, if they be over the average, comes a severe censure, causing greater care to be used in the future, for fear of a similar result. Third week, night duty. On this duty he will be abstract clerk—*i.e.*, have to enter the number and details of the messages in a book specially kept for the purpose, also to add up and record against the names of the various clerks on duty for the day the number of words received and sent by them. In addition to this he will perform the office of *cook*. And here let me say a few works as to night duty, which I believe causes quite a shiver of fright to seize upon the worthy parents of probationers, owing to their imagining it to be something equivalent to "sentry-go," or such-like horrors. Let me say, Sir, that it is nothing of the sort; the clerks on night duty get their eight hours' sleep and eight hours' play, as well as the rest, and although perhaps a little difficulty may be experienced in sleeping at rather different hours to the usual custom, this is soon overcome, and if the clerk makes up his mind to have his regular time for going to sleep, be it in the morning directly after coming off duty, or be it in the evening before duty, go to sleep he will to a certainty, whether he like it or no; at least, such has been my experience. Again, the company provide coffee, meat, &c., for night duty, and it is the business of the abstract clerk as cook to boil the coffee, &c., and generally look after the eating arrangements. So, Sir, I do not think there is much to grumble at here.

In addition to the duties above mentioned the probationer may have his work varied by being sent out with the linesman, and thus get an insight into the practical work connected with keeping a line in repair, &c.; or if, as Mr. A. says, he shows a taste for mechanical work, he will be allowed opportunities for working in the workshop; he will learn how to lacquer, turn, file, &c.; and, again, he will take his turn in the battery room at filling, cleaning, and looking after the batteries—all interesting work, and which, if he use his opportunities aright, he will be able to turn to account in after life.

Now, Sir, I think I have pretty well exhausted the probationer's course as regards the practical part of the work. I have not said much about the scientific part, since that has already been so ably described by Mr. A.

(TO BE CONTINUED.)

PHYSICAL SOCIETY.

FEB. 28.—Professor W. G. Adams in the chair.—A paper was read

ON SOME EFFECTS OF VIBRATORY MOTION IN FLUIDS. BY R. H. RIDOUT, F.C.S.

The author referred to his investigations into the structure of sensitive flames, published in *Nature*, and described the experiments he made to substitute water for gas. Finding the line of investigation taken by Savart and Tyndall unsuitable he caused the vibrations to be communicated to the water itself. The apparatus consisted of a straight glass tube joined to a water supply by a rubber tube. An electro-magnetic engine worked a lever which pinched on the tube about 400 or 500 times per second. The issuing jet spread out into two streams, which were beautifully beaded and represented the fundamental tone. When the lever vibrated irregularly harmonies were shown by the two main streams being supplemented by several smaller ones. Each particular clang tone in the note was evident on the jet. When the water was thrown into vibrations in two planes the resulting jet rotated in the tube. Froude's deduction that a liquid moving in a tortuous tube without friction had no tendency to straighten it was illustrated by a simple experiment. A small hollow cone rested on pivots on the top of a tall vessel filled with water. On pouring a coloured liquid into the cone, and giving it a motion on the pivots, the stream passed through the water is a perfect wave. By giving it a motion in two planes the wave was spiral, and a sounding body produced no disturbance in the stream.

ON THE PNEUMATIC EXPERIMENT OF M. CLEMENT DESORMES. BY R. H. RIDOUT, F.C.S.

The author showed how Desormes' cardboard experiment with air might be extended to water. A glass tube ¼in. bore had a hollow cup blown on one end. On passing water through the tube a glass globe was lifted by the cup against gravitation, and when both were immersed in a vessel of water the globe was still lifted. In explanation it was shown from experiments that the globe and cup remained in such a position that the outflow of water was greater than if the globe had been entirely absent. In a vessel of water, and filling a coloured liquid into it, which is seen to flow from the nozzle through the water in a tortuous line, by giving the pipette also a motion round its axis, the line becomes a spiral. A sounding body produces no disturbance in the stream. The author also showed that the cardboard experiment of M. Clement Desormes can be extended to water. In this experiment a card is attracted to another card by blowing a jet of air through the latter upon the surface of the former. Mr. Ridout allows a jet of water to flow out of a glass tube, with a cup-shaped mouth, upon the surface of a glass ball, and when the ball is within a certain distance of the mouth it is attracted towards the latter, and sticks on the mouth. In explanation of this fact, it was shown that the ball and cup remained in such a position that the outflow of water was greater than if the globe had been entirely absent.

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Professor PERRY explained this action by the hydro-dynamical fact that the pressure is less at the centre of the mouth of the cup than at the edges.

Professor GUTHRIE said that he had tried a similar experiment with a funnel-shaped mouth and a glass cone, but failed. He surmised that perhaps the cohesion of the water for itself, as it formed a shell round the ball, might help to cause the success of the ball method.

Professor ADAMS pointed out that with the cup and ball there was less difference of head of water between the centre of the mouth and the edge where the water escaped than with the funnel.

Dr. STONE stated that he had been able recently to imitate many physiological sounds, such as the murmur of the heart, by means of constructions in tubes through which water and air were flowing. His demonstrations were made before the Royal College of Physicians.

Dr. C. W. WRIGHT then read an important paper

ON A DETERMINATION OF CHEMICAL AFFINITY IN TERMS OF ELECTROMOTIVE FORCE.

After giving a history of the subject, he described his original experiments. These consisted in performing electrolysis of sulphuric acid, and measuring the heat evolved in the process and by recombustion of the materials. A voltameter with spade-shaped platinum electrodes soldered to stout copper wires, and sealed by a large plug of gutta percha, was employed for the electrolysis. An ordinary water calorimeter was used to measure the heat given off, as Bunsen's was found to contain sources of loss of heat. The strength of the current employed was varied from 6 Webers to $\frac{6}{10}$ Weber. The volume of gas produced was measured by Joule's plan. Radiation loss was corrected for by three methods. From an average of eighteen experiments the value of e, the electromotive force was found to be 1·5038 C.G.S., or volts. Taking the formula $J = \frac{e}{(H + h)\chi}$, where J is Joule's equivalent, H is the heat actually evolved, h the heat evolved by the recomposition, and χ a constant, to which Kohlrausch gives the value of ·000105, Dr. Wright finds that Joule's equivalent should be $4{\cdot}196 \times$ by 10^7 instead of $4{\cdot}20 \times 10^7$ as given to answer the formula. The author thinks that Joule's water-friction experiments gave the truest value of J, and that his electric heating experiments gave a result about $\frac{1}{2}$ per cent. too low, owing to the B.A. unit of resistance being about 2 per cent. too high, and other causes.

THE DIRECT UNITED STATES CABLE COMPANY (LIMITED).

Report of the proceedings at the fifth ordinary general meeting of the Direct United States Cable Company (Limited), held at the City Terminus Hotel, Cannon-street, on Friday, 27th February, 1880, at twelve o'clock noon; JOHN PENDER, Esq., M.P., in the chair.

The notice convening the meeting was read.

The CHAIRMAN: Gentlemen, as you have had the report in your hands for some days, I presume you will take that as read. I should like in the first instance to make a few remarks as to the figures in the report, in order, if possible, to make it so clear that there may be no difficulty in discussing it on its merits. It will be seen from the Company's accounts that our revenue for the half year to 31st December last, after deducting rent of land lines and payment to Anglo Company, amounted to £120,445 8s. 6d.; and the working and other expenses, including debenture interest and income-tax, absorb £25,001 3s. 6d., leaving a balance of £95,444 5s. as the net profit of the half year, making, with £2,345 1s. 5d. brought from the previous half year, a total of £97,789 6s. 5d., which has been appropriated as follows:—Two interim dividends of five shillings each per share for the quarters ended the 30th September, and 31st December, 1879, together requiring £30,355, have been paid; an amount of £48,942 2s. 9d. has been added to the reserve fund (which is thereby increased to £150,000); the sums of £1,900 on Preliminary Liquidation and Arbitration Account, and £914 7s. 1d., the cost of removing spare cable have been written off, and the balance of £15,677 16s. 7d, is carried forward to the next half year. Our revenue in the past half year, as compared with that in the corresponding period of 1878, has increased by the sum of £30,501 13s. 10d. This satisfactory result is mainly owing to the revival of trade between this country and America. The working and other expenses show a balance of increase of £3,250, which is accounted for as follows:—Compromise of Colgate suit, including law and other charges incidental thereto, £2,560. I think it is right I should explain to you that this Colgate suit is the reversion of an old patent which was obtained in America, and a claim in respect of royalty upon the covering of copper wire with gutta percha. That patent existed in this country, but expired many years ago. The American patent in some way or other had been in existence at a later date, and curiously enough the inventor, or rather, the trustee of the inventor, took the question up and gained a decision in more courts than one in America. Therefore, that involved a compromise; but, fortunately for us, we got out of the matter by that compromise at a comparatively small expense. I believe that the trustee of the inventor in America has got a very large sum of money from land lines in America in virtue of that patent. Then there is the opening and furnishing new stations in America and building in Ireland, £830; extra printing and stationery, £410; maintenance and renewal of instruments, £360; debenture issue and miscellaneous, £720; making a total of £4,880. But, as against this increase, there are many items of decrease, amounting to £1,630, leaving as net increase of expenditure £3,250. Omitting from these details the special expenditure *re* Colgate, it will be seen that the other items of increase were unavoidable, inasmuch as without the extra outlay it would have been impossible to earn the largely increased revenue. The above explanation of the increase in our expenditure, &c., having been given, no other item in the accounts appears to call for special remark [applause]. Now, gentlemen, I hope I have put before you very clearly the state of our finances, and I think I may congratulate the shareholders on their very satisfactory character. Therefore I need trouble you no further with these details. No doubt there are gentlemen in the room who may require to ask some questions on those accounts. If so, I shall be very glad to reply to any criticisms that may be made upon them. I may also congratulate you on the fact that since April last our cables have been working in every way satisfactorily, and the result has been the large return which your accounts show. I have no doubt that there are many gentlemen present who will be naturally anxious to know how we stand in relation to the new French cable [hear, hear]. It may be in your recollection that six months ago I gave you an outline of the French competing scheme. Since then the line has been completed, but I can scarcely say yet that it is open for general traffic. Messages have passed over the line, but at the present moment the telegraphing public know very little about it, and I suspect those who are immediately interested in the cable know a great deal more than it would be pleasant for them to communicate. So far they are very much in the position which I indicated—they are doing no good for themselves, but they are inflicting damage to a very considerable amount on telegraphy generally. I also stated six months ago, when those shares were at a premium in France, that in my opinion before twelve months were over they would be at fifty per cent. discount. I saw those gentlemen who formed the syndicate, for I went to Paris for the purpose of doing so, because I thought it was only right that those men, who must be ignorant of telegraphy generally, should be informed on the subject. I found one of them sitting at his desk with his pen in his hand, and I told him to make this note—that in twelve months, if I then returned to France, I should be able to sympathise with him on the loss of fifty per cent. of his property. To-day I can prove the truth of the prediction, for I now hold in my hand an official quotation from France, made only yesterday, which states that the shares have been sold at £11 each, which is close upon fifty per cent. discount. We may infer, therefore, gentlemen, that the cable manufacturers, the syndicate, and the French public generally, are in no way satisfied with their bargain. The contractors have pretty well exhausted England, as you who formed this Direct company know. For three years the shareholders got nothing out of this Direct company; and the syndicate lost £550,000. I have no doubt at all that if the new French cable were to fall into better hands, those better hands will probably by business-like arrangements be able to bring about the same result which has been brought about on our system; but then, gentlemen, it will be at a loss of about 50 per cent. on the original cost of the cable. As I have said they have exhausted England, I may say that they have pretty well exhausted France by this time also; and we are informed that they next propose to try Belgium, and, if that fails, Germany. But I should say that after the two attempts which have been made by the same parties, in which they have so signally failed, in carrying out the promises made in their prospectuses they will find out that other countries are not likely, particularly Germany, to engage in such a losing game. Schemes, such as the French cable scheme, are got up, as you are aware, by contractors and syndicates simply for the purpose of getting money upon the transaction, regardless of all consequences to telegraphy or to the investing public. Within a year they may get up a company, and within a year they may lay the cable, and hand it over to the Company; the public lose their money, the contractor probably puts something into his pocket, unless he has taken the amount of his contract in shares, and the result is that he goes elsewhere to find out another field for his enterprise. When telegraphic enterprise was first started, syndicates were a necessity, as it was almost impossible to get money from the general public; but now that telegraphy is established as a commercial necessity, and its real value ascertained, the public are not likely to subscribe for any enterprise unless they see a return commensurate with the risk. I have always held at public meetings of telegraph companies which I have had the honour of addressing that submarine telegraphy ought to pay from 8 to 10 per cent. dividend. I hold the same opinion now. It is a very curious fact, if you look at the telegraph companies generally, that the public estimate and value the telegraphic enterprises pretty much at that rate. No doubt in the early days of telegraphy 10 per cent. was necessary; but now that the public estimate the value of the telegraphs more accurately, and consider them more secure as a property, the returns are less. I may say that the telegraph returns upon the price which you can buy them at to-day give something like from 6 to 8 per cent. The amount of money at present invested in cables is about £25,000,000; the amount of reserve fund put aside by all the telegraph companies amounts to £1,630,000; but to replace the deep sea portions of these cables, an amount of £12,500,000 would be required, and until this amount is obtained it would not be wise in my opinion to consider submarine telegraphy in the sound position in which its friends would wish it to be placed. On this point I think it necessary to be very clear and distinct, so that there may be no misunderstanding betwixt shareholders and directors. The Direct Company's cable has been laid nearly six years; for three years, as you are aware, it paid no dividend, and put aside no reserve. It has been nearly three years under the present direction, and in that time we have paid you a dividend of 5 per cent., and have accumulated an amount of £150,000 for reserve. Had the proper course been pursued from the beginning, and a proper reserve laid aside, we should have at the present time £300,000 as a reserve fund. The average life of a cable is said to be ten years, but as to this much depends upon the bed on which the cable is laid. I believe it would be difficult, if not impossible, to raise a cable from 2,000

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fathoms after being ten years under water; still, it is quite possible that a deep sea cable might live for twenty, thirty, or forty years, or even longer so far as the insulated core is concerned, because in all our raisings of cables that have been in the sea for a very considerable time, we find that the gutta percha is almost indestructible as far as sea water is concerned. As that is the life and heart of a cable, if you could only get armour plating sufficiently strong to resist the action of the sea water a telegraph cable might live for a very long period. However, let us assume the life at ten years. The reserve necessary to replace the deep sea portion of our cable in that time would be £52,300 per annum, but if we raise the life to fifteen years we should require £32,300 per annum. I think, gentlemen, the safer principle to go upon is to put aside the larger sum, and when we exceed the ten years and our cable is still living, and in a profitable working state, then the Company can afford to pay a very considerably increased dividend, or probably it would be better to give bonuses. I submit, therefore, that the policy, not only of this Board, but the policy of all Boards of submarine telegraph companies, should be to accumulate a large reserve. There is another point I must touch upon, and that is the often expressed desire in certain quarters for reduced telegraph rates. Now, I think I have shown you that a reserve fund is a necessity to secure permanency of telegraph property, I think I can now show you that the reduction of rates from the commencement of telegraphy has been very striking indeed. When the telegraph was first established, the tariff across the Atlantic was £20 a message; it has gone down steadily, and now an average message costs 30s., in fact, a message can be sent across the Atlantic for 9s. When we reflect upon the ingenuity of the code and packing systems, we find that the amount of matter that can be transmitted at this low rate is almost beyond calculation. I may repeat what I have often stated at these meetings—if we had now an open system, instead of the code system, to deal with, for the matter which is passed over our lines we should realise the most sanguine anticipations entertained in the early days of telegraph property as to dividend. I remember myself, in the very early days of telegraphy, talking with Mr. Cyrus Field, and his saying that nothing less than 50 per cent. would satisfy him as a proper return for these telegraphic cables. That was a very sanguine view; but, if the open system had been continued to-day, it would have proved pretty much what he stated. But the ingenuity of the coding and packing system has reduced us, as I will show you, to a very low dividend indeed. It is the public who have really got all the benefit of the telegraph. If we take the capital of all submarine cable companies at the present moment, we find that the amount is over twenty-five millions sterling, and taking all the dividends that are earned upon these twenty-five millions, we find it to come out at only 4-$\frac{3}{8}$ths per cent. It would therefore, I hold, be unsound policy both in the interests of shareholders and of the telegraphing public, to talk of reducing rates at the present moment. We must remember that a submarine cable can only carry a certain number of words, and, taking the working time of a cable, it requires 3s. a word to give but a very moderate return upon the invested capital in these Atlantic systems. So far as the Atlantic tariff is concerned, any reduction leading to an increase of messages would not lead to a larger return in money, because at a low rate it would be impossible for a cable to carry the number of words required to make it pay. To carry messages at a low rate additional cables would be required, which, of course, involves additional outlay of capital and reduction of dividends. The present tariffs are in no way checking telegraphy, as we may plainly see, if we take last year as an evidence, for there is a large increase in the return of telegraphs generally. As I have often said, telegraphy is the best barometer we have of trade. With good trade the returns rise rapidly. With bad trade they become correspondingly depressed. The increase in the telegraph companies' returns is one evidence, which I think we have all good reason to congratulate ourselves upon, at the present moment, that not only in America, but also in India, and, in fact, throughout the world, trade is getting into a brighter and sounder position; and that is an evidence which I believe will brighten many a home [hear, hear]. We must deal in this question of telegraph tariffs with averages, and I hold that the rates we are now charging are a fair average, and must be maintained until the reserves I have indicated are secured. Having now shown you by figures that it is desirable to largely increase the reserves, and that it is undesirable and impolitic to reduce tariffs, I will just say one word as to the position which submarine telegraphy occupies at the present moment, and what it has had to contend with. Telegraphy has had little or no support from governments. Governments have never hesitated to grant concessions to anybody who might apply for them, encouraging, as they say, competition. They even go so far as to prevent any cable landing upon their shores (I am speaking of England, France, and the United States) who hold any concession or special privileges, while they do this, throwing every obstacle in their power in the way of submarine telegraphy (and I should be glad to have an opportunity of proving this to the governments) becoming a remunerative enterprise, although they admit it has become a great necessity both for Imperial and commercial interests. But instead of dealing with it on the same principle that they deal with their own telegraph systems, which in every country is a vast and close monopoly, they are strict to a degree in upholding their own monopoly, but they lose no opportunity of destroying what they are pleased to term the monopoly of submarine telegraphy. I hope the governments will see these things in their proper light, and that they will consider well when concessions are asked for, whether they are sought in the interests of the public generally, or are meant to enrich speculative contractors, to the destruction of sound telegraph enterprise. Telegraphy does not admit of undue competition. It has had to be established at enormous cost, and is of a very speculative and uncertain nature. Until science has done more than it has yet done to render cables permanent, the greatest caution ought to be observed on the part of governments, and I may say also on the part of individuals, in order not to destroy the fabric which has done so much, not only to promote commercial interests, but civilisation to a degree more rapid than anything has yet been known in this or any other time in the history of the world [applause]. Gentlemen, I have felt it necessary to-day to give you a few details, which I dare say will be interesting to you, as showing the position in which telegraphy is at the present moment. I believe that the value and usefulness of telegraphy is only beginning to be felt at the present moment. Great as the benefits are which it has conferred upon mankind, there are still greater benefits to be conferred by it; and I think that all those who have been interested in telegraph enterprise from the beginning may congratulate themselves upon the fact that they not only have had a moderate dividend, but they also have the satisfaction of knowing that their property is an increasing property, and that they have conferred an enormous benefit upon the commercial interest and the public generally [hear, hear, and applause]. Gentlemen, having troubled you with these few remarks, I beg to move the following resolution:—"That the report of the directors, dated 13th February, 1880, together with the statement of accounts to the 31st December, 1879, annexed thereto, be and the same are hereby received and adopted."

Mr. W. FORD: I beg to second the resolution.

Replying to Mr. Jackson and Mr. Newton,

The CHAIRMAN said: Mr. Jackson has entirely endorsed the policy of the Board. He has asked the Board to stand on that policy; but he has stated that so far as our cable is concerned we are in a very uncertain and very unsatisfactory position. I do not agree with Mr. Jackson in that respect, because our arrangements with the Anglo-American Company are of a very satisfactory nature. We should have ample time to repair our cable if it were to break, without suffering in any way in our dividends. At the same time, were it to break in deep water there is no doubt at all that we should require to find a new cable. Our cable is still young and healthy and I think it is in that position which, if it were to break to-morrow, as we have got a very good nest egg to begin with, and plenty of time to repair it, and sufficient shallow water that would limit the amount required for the cable to a very small proportion indeed. I take, therefore, a much livelier and brighter view of our position so far as as our own cable company is concerned than Mr. Jackson does. We are, certainly, the junior partner; but we are supported by all the means, and all the powers of the Anglo-Company with regard to help in case of need. I do not go in for monopoly, I have always been opposed to monopoly. When we extricated this Company from its troubles we were most decided in that view; we felt that to be absorbed by the Anglo-Company was simply giving place for another cable to spring up. As long as I have the honour of being chairman of this Company, it will never be considered a monopoly, as I am opposed to monopolies altogether. I say that submarine telegraphy is a matter of enterprise, and is not ground to be poached upon by any other class of property. It is an uncertain property, as we all know, and that man who came forward to induce other people to find money to lay cables where they could get a better security for half the price at the same moment shows that the public are still what I will call very gullible indeed, but I hope that every day is opening their eyes in that respect. With reference to Mr. Newton's question, I was going to make the reply which Lord Monck did, which I think was a very sound and proper reply. Only last night in the House of Commons a question was put to one of the ministers, and the minister's reply was "During negotiations it would not be to the public interest that anything should be said about it." During the present stage of negotiations between the French and English companies, I think the less said about it the better [hear, hear]. All I can say is, that they are doing nothing, and with a large capital lying unemployed, every day is strengthening our position and weakening theirs. You may depend upon it, when it comes to close quarters, if a bargain is ever made, that the interests of the shareholders of this Company will be fairly protected.

The resolution was then put and carried unanimously.

Mr. JACKSON: I beg to move that the best thanks of this meeting be accorded to our worthy chairman for the way in which he has presided over the affairs of this Company. He is a gentleman who is not only A 1 as a telegraph director, but is so devoted to our interest, that I am sure we shall not hesitate for a moment to express the gratification we feel in having the opportunity once more of expressing our acknowledgments for the services of himself and his Board.

The motion having been seconded, was put by Mr. Jackson to the meeting, and carried by acclamation.

The CHAIRMAN: Gentlemen, we are very much obliged to you for this renewed mark of your confidence. I am sure there is nothing more gratifying to my co-directors and myself than to find that our shareholders are satisfied. I think that, looking to the affairs of this Company altogether, we have reason to congratulate one another at the respectable position in which we find ourselves to-day.

The proceedings then terminated.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).

The sixteenth ordinary general meeting of shareholders of the above company was held on the 2nd inst. at the City Terminus Hotel, Sir Daniel Gooch, Bart., M.P., presiding.

The SECRETARY (Mr. W. Shuter) read the notice convening the meeting, and subsequently the minutes of the last ordinary and half-yearly meetings, which were approved by the present meeting, and signed as correct by the chairman. The report, which appeared in *The Electrician* last week, was taken as read.

The CHAIRMAN, in moving the adoption of the report and accounts, and a dividend (tax free) of £1 16s. per share (making with the interim dividend 20 per cent. for the past year) said that he need not detain them very long, because the affairs of the Company were set out so fully in the report, which, no doubt, they had all read. During the past year they had manufactured 6,917 miles of cable. The result in money was that they showed a net profit during the year of £98,988, after deducting the interest charged on their debentures. They brought forward from the previous year an amount of £59,353, making together £158,341 to dispose of. Out of that they gave an interim dividend of 5 per cent. in July last, which absorbed £22,410, and now the directors proposed to distribute a dividend of 15 per cent. for the past half year, which would require £67,230, and leave to be carried forward £68,701. That he thought was a very satisfactory statement of their financial working in the past year. The work done had been the duplication of the Australian cable, which they began very

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early in the year, but the completion of it was postponed in consequence of the necessity which occurred for the carrying out of the contract for the Cape cable, and the Australian Governments were good enough to consent to the postponement of the completion of their cable, so that it might be used for the completion of the Cape cable. They did not complete the Australian cable, therefore, till the beginning of the current year. With regard to the Cape cable, they laid that cable of 3,845 miles during the year, and it was successfully laid. Unfortunately, a break had taken place close to the shore of Mozambique, and when it happened there was no ship nearer than Aden to repair it. They had, however, that day received information that the ship had arrived on the ground, and no doubt in a day or two that breakage would be put right. It was a very bad bit of ground where it was broken, and some steps must be taken by the Cape Cable Company to see if they could find a better piece of ground. They started a ship on Saturday with 555 miles of cable to lay a line between a point near Manilla, in the island of Luzon and Hong Kong, and that work would be completed in the month of May. That was for the Eastern Telegraph Company. They had carried out a contract for the German-Norwegian Telegraph Company to make and lay a cable between Arendal in Norway, and Hoyer, on the coast of Schleswig. That operation was completed in August, and the length of cable was 256 miles. Last December they entered into a contract with the Government of New Zealand to lay a cable of 120 miles in that colony, and they had heard that day that the cable was laid, and that the ship was on her return home. The total length of cable manufactured in the year was, as he had said already, 6,917 miles, and they were, he thought, indebted to the officers and others who had been engaged in laying these cables for the care and ability with which they had completed their work. It was a very large extent of cable to lay, and they had had no misfortune to report. The accounts were set out in full detail, and, therefore, he did not think it necessary to refer to them further, but he should be very glad to give any explanation which might be required relating to them. They hoped that the present prosperity of the Company would continue; perhaps it might not be quite so great as it had been hitherto, but, at any rate, as far as the directors were concerned, they would do their best to carry on the Company's work satisfactorily. He concluded by moving the resolution.

Mr. PHILIP RAWSON seconded the motion.

Mr. WILLIAM ABBOTT thought that every one would endorse the chairman's remarks about the shareholders' obligations to the officers of the Company for the skill and ability which they had displayed in carrying out the work of the past year. He was in the habit of asking the Chairman many questions at the meetings of the Company, but he was also in the habit of receiving very scant replies. He had no doubt that both the chairman and he had the same end in view—the welfare of the Company—and that no undue inflation might be stimulated in the minds of the shareholders as to what might take place in future, he had made a small calculation, and found they had laid 6,917 miles, and that the net profit amounted to exactly £15 per mile. Considering the risks they ran in cable laying, he did not think their customers could make any complaint at the amount of net profit made by the Company on the works they had carried out. He should be glad if the chairman would inform them whether the distribution of dividend, which was very satisfactory to him, though it might have been very much larger, was limited to the usual 20 per cent. on account of the fact that they had securities to the amount of £343,365. He presumed that they had to render a considerable amount of assistance to the Cape company, and also to the other companies for whom they had done work, and that when those securities were in a liquid state the profit would be fairly divisible among the proprietors. They did not live for posterity—posterity had done nothing for them, and, therefore, it was desirable that the shareholders should see a little of the return in their life time, and not wait for all their reward in the next world.

The CHAIRMAN said Mr. Abbott was wrong in supposing that the Company had laid 6,917 miles of cable during the year; they had constructed that amount of cable, but the whole was not laid. As he had said in his opening remarks, the Australian cable was not laid till the beginning of the present year, and the accounts connected with that work did not come into the accounts under consideration. As he had told the shareholders many times, the success of the Company hitherto had been owing to their having large funds in hand. Without large funds in hand they could not have undertaken the Cape cable. It was very well known that the Telegraph Construction Company had to take practically two-thirds of the capital of the Cape Cable company upon its own hands, the Eastern Company taking the other third; but if they had not had those large available sums in hand they could not have undertaken the Cape cable. Therefore, although it looked a large sum in hand, yet their success depended on it. He was as deeply interested as anyone in having a large dividend, but still he looked to the prosperity of the concern, not for one year, but as a permanent investment for their capital, and he was quite sure that the course they had hitherto taken was a wise one. He did not think anyone could complain of 20 per cent.; he only wished he had that rate or half of it from other companies he was interested in. He hoped the shareholders would not inquire too closely into the matter referred to by Mr. Abbott, but that they would trust the directors, who had hitherto not deceived them. He thought that the accounts placed before them showed pretty generally the state of the Company financially. He then put the motion, and it was carried unanimously. He next moved the re-election of Lord Alfred Paget to his seat at the Board.

Admiral Sir GEORGE H. RICHARDS, C.B., F.R.S., the managing director, seconded the motion, and it was carried unanimously, as was also a further resolution, proposed and seconded by the same gentlemen, for the re-election of Mr. George W. Campbell.

On the motion of Mr. W. ABBOTT, Mr. John Gane was re-elected an auditor of the Company, and Mr. James Glegg (of the firm of Quilter, Ball, and Co.) was elected the other auditor, to fill the vacancy caused by the death of Mr. John Ball, who, the chairman stated, had served the Company for many years, and paid great attention to their affairs. Mr. Glegg had been a partner of Mr. Ball's, and had lately assisted in the audit.

Mr. WILLIAM FORD said that notwithstanding that the directors had thought it prudent only to declare the normal dividend of 20 per cent., and notwithstanding that they had thought it prudent not to supplement it by a bonus of 20 per cent., notwithstanding, too, that they had thought it expedient to carry forward £68,000 odd, he still thought, in spite of these shortcomings on their part, that they were deserving of a hearty vote of thanks. He hoped next year that they would have a larger dividend, a bonus, and that they would carry forward more.

Mr. ABBOTT, in seconding the motion, thanked the chairman for the information he had given him. It was true it was not much, but it was all he required.

The resolution was carried unanimously.

The CHAIRMAN thanked them for the renewed vote of confidence which they had passed. He could assure them that the interests of the Company had the deep thought and attention of the directors, and he hoped that they would meet under such pleasant circumstances for many years to come.

Mr. FORD then said that the shareholders would concur in the remarks of the chairman as to the services of the officers of the Company's ships who had been engaged in the various expeditions the results of which had been so successful. He was sure that those shareholders who were acquainted, as he was, with the great difficulties of the various expeditions would appreciate as fully as he did how much they owed of their prosperity to the energy and skill of those officers. He was extremely glad to hear them mentioned. He was sure that the shareholders would concur in passing a vote of thanks to the various officers and the staff of the Company.

Mr. HANCOCK expressed his pleasure in seconding the resolution. He had known some of the men referred to for 20 or 25 years, and he was sure that the great success of the Company had been due as much to the great care, experience, and skill of the officers as to the straightforward and honourable conduct of the directors.

The CHAIRMAN put the motion, and it was carried unanimously, and the proceedings then terminated.

MEDITERRANEAN EXTENSION TELEGRAPH COMPANY (LIMITED).

The forty-fifth ordinary general meeting of the shareholders of this Company was held at the City Terminus Hotel, Cannon-street, on the 3rd inst., under the presidency of Sir James Carmichael, Bart., chairman.

The SECRETARY (Mr. E. Tombs) read the advertisement convening the meeting, and the report of the directors was taken as read. It stated that the last half-yearly balance sheet of the Company showed a slight improvement over that of the previous half year. The cables were in good condition. They recommended payment of the usual dividend at the rate of 8 per cent. per annum, less income-tax, on the Preference Stock, and of a dividend at the rate of 3 per cent. per annum, free of income-tax, on the Ordinary Stock of the Company, on and after the 10th March, leaving a balance of £48 to be carried to the reserve fund. The revenue account showed that the receipts from messages during the half year ending the 31st of December last had been £2,281, and the amount due from the Government under the guarantee was £3,600.

The CHAIRMAN, in moving the adoption of the report and account, expressed great regret at the delay which had occurred in holding the meeting, which was usually held in February, and, as they were aware, the dividend was usually paid on the 1st of March. The delay had not arisen from any *laches* on the part of any of the officers or directors of the Company; but, unfortunately, the official auditor of the Treasury had demurred to the claim which the Company had made for payment of the guarantee—at least, they demurred to a portion of it. They thought that they were entitled to it, and the matter was still under the consideration of the Treasury. They had endeavoured to get this settled before the meeting of the shareholders, but as that seemed to be impossible they thought it better to leave the matter for the discussion of the Treasury, and he hoped that at the next meeting they would be able to make a favourable report to the shareholders on the subject. Those were the only remarks he had to make on the report and balance-sheet, but he should be happy to answer any question or give any information which might be required.

Mr. HARRIS having seconded the motion,

Mr. C. ROBINSON thought they ought to have some little explanation as regarded the different matters which were going forward with respect to the Company—for their prospects for the future appeared to be no brighter than they were at present. When they found the Government objecting to pay what the Board considered the Company ought to receive, the shareholders ought to ask the question in what position the Government stood towards them in respect to the guarantee, and, further, whether the amount they objected to pay the Company was a sum which they could legitimately claim back from them or not. Their solicitor was present, and he might tell them whether it was better to meet the dispute by an amicable arrangement, or whether they should insist on their rights. He thought they had very much truckled to the Government as to this matter. The Treasury were imposing very onerous exactions on them, and they seemed to dictate to the Board what they should do and what they should not do. He had several times made remonstrances with the Government, but they had not had the effect on their interests he could wish. They must look to themselves and not to the Government. The diminution in their expenses was considerable, and their cables were in perfect order. He thought a remonstrance from the shareholders would convince the Government that they must deal more liberally towards the Company. The Company had been in existence many years, and it was a disgrace to the Government that they should ever have sanctioned a competing line. Instead of promoting the interests of this Company, they promoted the interests of a company which was diametically opposed to it. He knew that many of the messages which the Government sent did not come to the Company, although it would be thought that, as the Government had to pay the Company a guarantee, they would send all the messages they could through the Company, so as to reduce the liability they were under to the Company. This question had been brought before them lately, and he understood that they had now more messages. At one time, however, they received scarcely any of the Government messages. He thought the directors would be assisted very much by a large attendance of the shareholders at their meetings, and that some remonstrance should be made by the shareholders to the Government. Seeing the difficulty they now had in obtaining messages from the Government, when the guarantee expired they would receive no messages from

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that quarter. At present the shareholders seemed to think that because they received this interest each half year it was to last for ever, and, therefore, they took no heed of the position of the Company.

The CHAIRMAN thought the last part of Mr. Robinson's remarks almost answered the first, for the Government had a right to terminate the agreement. It had nearly four years to run. If they could end the guarantee it was surely not their interest to quarrel with their paymasters. They must do all they could to carry on their business in an amicable manner. He had never found the Government hard taskmasters. They had paid them he thought very fairly and liberally. They had now a question open as to which he entirely differed from them. It was a question open to discussion, though he thought it was a hard matter to press on the Company, but he hoped they would do all they could to carry their point. He certainly would not advocate taking legal proceedings against the Government. He thought the better way would be to leave the matter in the hands of the Board to negotiate. The present Government was not answerable for the competing line to which Mr. Robinson had referred, and which was, unfortunately, inimical to this Company.

Mr. CAMPBELL (the solicitor of the Company) thought the time had not arrived for entering into any legal discussion on the subject, and he hoped that an amicable arrangement would be made. Of course, if it could not be, legal proceedings must be taken, but he really hoped that that would not be necessary.

The CHAIRMAN said they must remember that legal proceedings were very expensive operations.

Mr. ROBINSON replied that he did not advocate legal proceedings, but suggested that as Mr. Campbell was present he might tell them whether the Government had a legal right to make the deduction in question or not.

Mr. CAMPBELL said they believed that the Government had not.

Mr. ROBINSON observed that there was another point in the Articles of Association which had, he thought, missed their notice. The only prospect of the Company becoming a valuable one to the present shareholders, or to their successors, was for them to endeavour to grasp some other line, or to make an arrangement with some other company, and at present he believed they had hardly any power to make arrangements or contracts with any company or government to make or lay any lines of telegraphic communication whatever.

The CHAIRMAN thought that Mr. Robinson was quite right.

Mr. ROBINSON held that they should have the power to grasp anything which might be put before them, and get the consequent advantage without any delay. He thought the power should be provided in their articles.

The CHAIRMAN thought that was a very valuable suggestion, and he should be most happy, if the shareholders generally approved of it, to instruct Mr. Campbell to carry it out by suggesting a clause to be drafted into the Articles of Association. That could be done by two meetings, if it were the wish of the shareholders. He thought it might be very advantageous to have such a clause in their articles.

The Hon. A. PONSONBY observed that they had often discussed the matter at the Board, but they thought the time had not quite come. However, it seemed to him that it would be quite feasible, and at their next general meeting, six months hence, they could make the meeting special, for the purpose of considering the question, and then call another meeting to confirm it.

Mr. ROBINSON remarked that there was an old saying, that if a thing were worth doing, it was worth doing at once.

The Hon. A. PONSONBY thought it would do if the subject were considered at their next meeting.

Mr. CAMPBELL thought it might be left in this way: That if anything occurred which was likely to turn out well for the Company they could call a meeting, but if not they would make the next ordinary meeting special for the purpose. It was simply a question of saving money and time.

The CHAIRMAN said he had always regretted the power referred to was not in the Articles of Association originally, but nothing had been before them to necessitate taking the powers. Though he considered it was a very valuable power, he thought it would, perhaps, be better to leave the matter as suggested by Mr. Campbell.

Mr. ROBINSON acquiesced, and the report was then unanimously adopted.

The CHAIRMAN then moved the payment of the dividends referred to in the report.

Mr. DELFORCE seconded the amendment. He said that the amount available for dividend was £3,000, and on the other side they had £3,600 owing to them.

The CHAIRMAN said that the amount was owing by the Government, and it was available for the dividend.

The SECRETARY stated that by various conventions with the Italian Government three months were given to them in which to close their accounts. This amount was available for dividend.

Mr. DELFORCE said he thought it might, perhaps, be the sum in dispute.

The CHAIRMAN replied that he was glad to say that the sum in dispute was much smaller than that. The motion was then carried unanimously.

Mr. ROBINSON moved a vote of thanks to the chairman and directors. He knew the difficulties they had to deal with at the present moment, but he had no doubt that with the assistance of Mr. Campbell they would convince the Government that their claim on the Company could not be legitimately held. It was far better to close with the Government amicably than to throw down the cudgels. They knew that it was a very difficult thing to get a case against a Government. He thought that the suggestion of Mr. Campbell was a very good one.

Mr. LLOYD seconded the motion, and it was carried unanimously.

The CHAIRMAN, in returning thanks, said they would use their best exertions to obtain what they thought they had a right to, and if they failed it would not be from any fault of theirs.

TRAFFIC RECEIPTS FOR FEBRUARY, 1880.

COMPANIES.	Feb. 1880.	Feb. 1879.	Incrse.	Decrse
Cuba Submarine Company	3,200 estd.	2,775	425	—
Eastern Telegraph Company	44,591	37,251	7,340	—
Eastern Extension Telegraph Company	25,190	22,409	2,781	—
Great Northern Telegraph Company	14,160	—	—	—

TELEGRAPH SHARE LIST.

COMPANIES.	CLOSING PRICES MARCH 3.		BUSINESS DONE WEEK ENDING MARCH 3. Highest.	Lowest.
Anglo-American Ordinary	59¾,	60¼	60	60
Do. "B"	88¼,	¾	89¼	88½
Do. "A"	31⅜,	2¾	32⅞	31⅛
Brazilian	7 13-16,	15-16	7⅞	7¾
Cuba x d Feb. 27	8¾,	9⅛	9 3-16	8⅞
Do. Ten per Cent. Pref. x d Feb. 27	16,	⅛	—	—
Direct Spanish	2,	⅛	—	—
Do. Ten per Cent. Preference	11⅛,	¾	11⅛	11⅛
Direct United States	11⅛,	⅜	11¼	11¼
Eastern	8 15-16,	9 1-16	9 1-16	8⅞
Do. Six per Cent. Debenture	103,	6	—	—
Do. Five per Cent. do.	101,	3	102⅛	101½
Do. Six per Cent. Preference	12,	¼	12¼	12
Eastern Extension	8⅜,	9	9 1-16	8⅞
Do. Six per Cent. Deb.	105,	8	107⅛	107⅛
German Union	8½,	9	8 13-16	8⅝
Globe Telegraph and Trust	5⅛,	⅝	5 11-16	5⅛
Do. Six per Cent. Preference	11 5-16,	7-16	11⅛	11¼
Great Northern	9⅛,	⅜	9 7-16	9¼
Indo-European	24,	6	—	—
Mediterranean Extension	3,	⅛	—	—
Do. Eight per Cent. Preference	10¾,	11¼	—	—
Reuter's	10,	11	—	—
Submarine x d Feb. 27	233,	8	236	234¾
West India and Panama	1 13-16,	15-16	1 15-16	1¾
Do. Six per Cent. Preference	7⅞,	8	8	7⅞
Western and Brazilian	7¼,	⅛	7¼	7 1-16
West. Union Seven per Ct. 1st Mt.	120,	5	—	—
Do. Six per Ct. Sterg. x d March 1	102,	4	—	—

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SLIP

ELECTRIC LIGHTING.—The Jablochkoff system is to be continued in the streets of Paris till May, 1881.

AMERICAN UNION TELEGRAPH COMPANY.—This company is building a line from Philadelphia to Pittsburgh, and from thence to Altoona.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The Company announce that communication is restored in their Para-Maranham section.

SCREENING MAGNETISM.—M. Jamin finds that a concentric tube of iron 6 millimetres thick will screen almost completely an interior core from the effects of an exterior spiral current.

THE BRUSH ELECTRIC LIGHT.— Seventy-one of these lights have replaced 578 gas burners at the Riverside Worsted Mills, Providence, R.I. The cost of the latter was 6.93 dollars per hour, the cost of the former is said to be 2.20 dollars per hour.

MAGNETISATION during hardening furnished magnets over six times stronger than those produced in the ordinary way; but their absolute strength was extremely small, because it was only with an exceedingly weak magnetising force that so great a difference appeared.

PRIZE ESSAY.—A "Prix Vaillant" will be awarded this year for the best solution of the question "How to perfect the phonetic telegraph in some important particulars?" The memoirs should be handed in on or before June 1. The prize is founded on a bequest of 40,000 francs by M. Maréchal Vaillant, and is given every two years.

RESTORATION OF COMMUNICATION WITH SOUTH AFRICA.—The fault in the cable off Mozambique having now been repaired, telegrams are again received for all South African stations by the Eastern Telegraph Company. It is requested that telegrams for South Africa may be handed in as early in the day as convenient at No. 11, Old Broad-street, No. 8, Leadenhall-street, or No. 3, Great Tower-street.

ELECTRICAL PROOF OF DEATH.—In a recent note we described the use of electricity as the only known means of diagnosing the presence of life in a body apparently dead. This is not a new application of electricity, for electro-bioscopy as it was called was known as early as 1792, and was treated exhaustively by Dr. Crimotel, in a work published in 1866 at Paris, under the title of "De l'Epreuné Galvanique." This test may safely be taken as the only reliable one for determining a true corpse.

SPECTRUM OF THE SPARK IN WATER.—Professor Abt of Klausenberg finds the discharge in water to give a coloured band spectrum, which gradually enlarges and becomes continuous as the spark is lengthened. It differs from the white carbon arc by deficiency of dark red and abundance of blue rays, and by extraordinary brilliancy. Other liquids, such as glycerine, alcohol, milk, &c., give varied spectra. Prof. Abt attributes the phenomenon to particles detached from the copper electrodes in appearing the liquid at white heat (?).

MAGNETISING STEEL.—From recent experiments made by Herr Holtz it appears that the magnetism of steel bars, magnetised during the process of hardening, is only conditionally superior to ordinary magnetisation, and that the superiority of magnetisation during hardening decreases where the magnetising force increases, where the thickness of the bar increases. It is greatest where, with weak magnetising force, the bar is at the same time partly withdrawn from the action of the means of magnetisation; and it is least where, with great magnetising force, a great thickness of bar is used.

THE ALMIGHTY DOLLAR.—Our cousins are not always so keen as regards business as not to make mistakes. It seems that one Simpson had a patent for insulating wire. This patent was sold to Mr. C. G. Colgate, who requires, according to the ideas of some of the companies, a little too much in the way of royalty. He has obtained from the Western Union and other associated companies 10,000 dollars as a compromise, having claimed 1,000,000 dollars. "Persons wanting cables must send to England for them, and an enormous prohibitionary duty on imported cables is threatened." So much the better for English manufacturers.

THE TELEPHONE.—The Sunderland Corporation has arranged with the Bell Telephone Company to establish a trial line between the office of the Town Clerk and that of the District Surveyor. A line has also been erected at Shipley, near Ilkeston, which connects the central office at the Shipley collieries with the coal depôt and with the Shipley Gate Station on the Erewash Valley line of the Midland Railway. Although the adoption of this valuable means of communication is making some progress in this country, it is stated that only 800 telephones are commercially used here, whilst more than 40,000 of these instruments are at work in the United States.

FRENCH PRIZES.—The *Prix Lacaze* for physical research has been awarded by the French Academy of Sciences to M. Le Roux, Examiner of the Polytechnic School, and Professor of Pharmacy at the School of Pharmacy, Paris. Among a variety of researches M. Le Roux has made important investigations on magneto-electric machines, the voltaic arc and electric light, as well as upon thermo-currents and the inductive effects of certain bodies in rotation, a phenomenon to which he has given the name of *peripolar induction*. The report accompanying the award gives him high praise for his invention in constructing his own apparatus, and for his sagacity and perseverance.

A NEW FORM OF MICROPHONE FOR PHYSIOLOGICAL PURPOSES.—Mr. Sydney H. Raynes, of the London Hospital, has devised a form of microphone which promises to overcome some of the difficulties experienced in using this class of instrument for examining the pulsations of the heart, &c. Usually the two carbons are both affixed to the membrane connected with the flexible tube. Mr. Raynes' arrangement is to fix the moveable carbon on a rigid stand, whilst the fixed carbon only is attached to the membrane, which is consequently small and very sensitive. Thus, instead of the whole of the microphone vibrating with the pulsations, only the lower block vibrates, and a more accurate record, consequently, is said to be obtained.

A NEW USE FOR THE TELEPHONE.—Hitherto (says the *Scientific American)* it has been a matter of some difficulty to determine the time of flight of small-arm projectiles owing to the impossibility of seeing them strike. In a series of experiments made by the U.S. Ordnance Department this difficult has been overcome by the use of the telephone. The telephone was connected with two Blake transmitters, one placed near the gun, the other in front of and near the target. The time between the report of the gun and sound of the ball upon the target was measured by a stop-watch. The observations, founded on a large number of experiments, never differed more than a quarter or half of a second from each other, the slight delay in starting the watch being neutralised by the delay in stopping it. It was found that the time of transit was affected by the wind, being shortened by a rear and lengthened by a head wind.

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THE SIPHON RECORDER.—There is a relic of old student days in the laboratory of Sir William Thomson, at the Glasgow University, when the Siphon Recorder had just been born into existence. It is a parody on Tennyson's well-known lines, after the manner of Clerk Maxwell, entitled, "A Farewell":

[By a telegraph clerk to the mirror galvanometer signal on the introduction of the "Siphon Recorder"]

Flow up swift message from the sea,
Thy pregnant tale deliver;
No more on thee my eyes need be
For ever and for ever.

Flow, softly flow, by wire and key,
But move the mirror never;
No more on thee my eyes need be
For ever and for ever.

But here will rock the light coil free,
And here the siphon shiver;
And all of thee will tell to me
For ever and for ever.

A thousand dots may stream from thee,
A thousand dashes quiver;
But not on thee my eyes need be
For ever and for ever. J. M.

FLOWER GROWING BY ELECTRIC LIGHT.—It is interesting to remark another scientific prediction, in the case of Dr. Siemens' curiously beautiful experiments on the growth of plants under the electric light, which are fully described on another page. More than a year and a half ago Mr. J. Munro, C.E., while citing in a contemporary the recent experiments of M. Grandeau on the influence of atmospheric electricity on vegetation foretold that electricity would be artificially applied in horticulture. In an article on "Electricity and Gardening," by the same writer, in *Cassell's Magazine* for March, 1879, he says, "Similar experiments by M. Celi have confirmed M. Grandeau's curious results, which point to a time when the atmosphere of a forcing-house may be advantageously charged with electricity, as it is now charged with heat. The nature of iron conservatories and vineries makes them act as a kind of screen to atmospheric electricity, and there is, therefore, all the more reason that electricity should be artificially supplied. In connection with this subject, we may add that Professor J. Macagno finds that in grape-growing a decrease in the intensity of the available light hinders the formation of sugar, and that the formation of other assimilated products is directly proportionate to the intensity of the light. Perhaps the time is not far distant when the electric light will be used for forcing rare fruits and flowers during our dark winters, as much as artificial heat is now." Verily the words of the prophet are fulfilled in the results of Dr. Siemens.

CITY TELEGRAPH BOYS.—The Post Office telegraph boys, to the number of 200 or more, belonging to the Eastern Central or City district, were entertained on Friday night, March 5, in the school room of the Falcon-square Chapel. After tea, cake, and oranges had been most liberally dispensed the chair was taken by Mr. Robert W. Johnston, the postmaster of the district, who was supported by Mr. H. Eaton (telegraph engineer for London), Captain Blanchard, Messrs. Powley, Smith, Smallwood, Turle, and other gentlemen. There were also present a number of the clerks in charge, and clerks of the City post offices where the boys are employed. The Chairman, in the course of a brief address, said that as the number of telegrams delivered in the City in the course of a year amounted to "some millions" the telegraph boy was an important factor in our commercial system, and that much depended on the care and attention with which he performed his duty. He would give them four cardinal points never to be lost sight of in their relations with the public. First, civility, because the public had a right to expect it from their servants. Secondly, celerity, because speed was of the very essence of the telegraph boy's duty. Thirdly, cleanliness, because the dirty boy was almost always idle; and fourthly, conscientiousness, because great temptations were placed in the way of City boys of all descriptions. The future of the civil, quick, clean, conscientious telegraph boy was by no means to be despised. After alluding to the fact that a grant had recently been made for forming a library for the use of the telegraph boys, the Chairman proceeded to present prizes of books to more than twenty boys who had distinguished themselves by good conduct, punctual attendance, and smartness of appearance, after which recitations, music, and a series of dissolving views were introduced and brought the proceedings to a close.

FAITH IN SCIENCE.—An amusing arbitration case has just been settled in Paris. M. Amouroux was summoned by the proprietors of the Grand Hôtel to quit possession of several rooms devoted to the electric bell apparatus. This, it appears, was "fearfully and wonderfully made," for whenever it got out of order the entire establishment was thrown out of joint. According to the plaintiffs, although the apparatus was destined to respond to the most complex orders to the servants, it frequently produced the most alarming results. One occupant of a private room would be ringing desperately and ineffectually, so far as he was concerned, but his next door neighbour would probably be disturbed by the appearance of several waiters officiously proffering their services, while elsewhere a lady who had summoned her chamber-maid would be astonished to hear that her carriage was waiting for her at the door. Amouroux nevertheless took matters philosophically, for, although his endeavours to perfect the apparatus were doomed to failure, his faith in science remained unshaken. He believed his own position was equally unassailable. Not so with the plaintiffs, however, for as "hope deferred maketh the heart sick," they sorrowfully resolved to give him a fortnight's notice to quit. He refused to accept it, arguing that he was not a mere *employé*, but a tenant, and as such had certain privileges with which the plaintiffs had no right to interfere. In support of this statement he urged that he had frequently done work for persons outside the establishment. This fact, one would imagine, was one which might have properly come within the plaintiff's brief. His advocate, however, maintained that the rental was a partial remuneration for the services he rendered within the hotel, and that he was at liberty to carry his scientific knowledge elsewhere. With the latter sentiment the Court agreed, Amouroux being ordered to leave within a fortnight in pursuance of the notice served upon him, there being no proof that he was merely a tenant.—*Galignani.*

ELECTRIC DILATION OF BODIES.—M. Duter, in continuing his experiments on this subject, has constructed two glass bulbs terminated by graduated tubes, the radii of the bulbs being respectively about 43 mm., the thickness $\frac{1}{2}$m. for the first bulb A, and 8-10m., for the second bulb B, each division of the tube being $\frac{1}{4}$m. These bulbs were filled with water, and coated with tin on the outside so as to form Leyden jars, which were then electrified, and the dilation of the bulbs was measured by the level of water in the graduated limbs. The corresponding electromotive force of the charge was also estimated by the explosive distance of the spark which it gave From a number of experiments M. Duter arrives at the following law, that the increase of volume of the bottle $U_l = \frac{KV^2}{e}$, where e is the thickness of the bulb, V the differ-

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ence of potential of the armatures, K a coefficient depending on the apparatus. If the changes of volume observed were due to electric pressure, they would not be inversely proportional to e, but to e^2. The dilation observed is too large to be accounted for by this pressure, and M. Duter considers it due to an unknown property of electricity. M. Righi, experimenting with a different apparatus, a glass tube, provided with liquid or metal armatures, having one end fixed and the other free to press on a spring which carried a small mirror capable of indicating the dilation of the tube by this means, has found that the above phenomenon of M. Duter is due to transversal dilation of the glass, and that it is needful to distinguish between *instantaneous* dilation, due chiefly to polarisation of the glass, and a *persistent* dilation due to a development of heat. It is probable also that the polarisation and, perhaps also, as suggested by Volta, the attraction between the armatures produces in glass a diminution of thickness. M. Righi attributes the phenomenon of Varley's singing condenser to the instantaneous dilations at each charge and discharge, for on putting one of his tubes having mercury armatures in circuit with the secondary wire of an induction coil which had its primary circuit harmonically interrupted by a tuning fork the tube reproduced the sound by longitudinal vibrations.

Postal Notice.—Under the St. Petersburg Convention, as revised in London, the following alterations in the regulations respecting foreign telegrams will come into force on the 1st of April next:—The principle of a word tariff, instead of a fixed charge for a *mininum* number of words, will be extended to European telegrams, and the charges will be the same from the country as from London. The compulsory collation (repetition) of cipher telegrams will be abolished. Proper names will no longer be allowed in the text of code-telegrams, unless used in their natural sense. In European code-telegrams any of the languages in use in the different countries of Europe, or Latin, will be allowed; but no telegram will be allowed to contain words drawn from more than one language. In extra-European code-telegrams, only the following eight languages will be allowed—viz., English, French, German, Italian, Spanish, Portuguese, Dutch, and Latin; but words drawn from any or all of these languages will be allowed in one and the same telegram. The charges paid by the addressee for the repetition of an inaccurately-transmitted telegram will be refunded. Numbers written in words will be counted according to the manner in which they are written by the sender. For example, "two hundred and thirty-four" would be counted as five words; but "two hundredandthirtyfour" as two words in European telegrams (15 letters to a word), and three words in extra-European telegrams (10 letters to a word). In extra-European telegrams groups of figures or letters will be counted at the rate of three (instead of five) to a word. The length of the reply to a telegram which can be prepaid by the sender will be limited to 30 words; and a form will be handed to the addressee enabling him to send a reply at any time within six weeks. Should the addressee not use the form, the amount paid for the reply will be returned to the sender, provided that the addressee returns the form within six weeks to the Post-office accompanied by a request that the money may be refunded to the sender. In no case will the amount be paid to the addressee. The charge for each copy (after the first) of a telegram containing a multiple address will be reduced from 5d. per copy of 20 words to 5d. per copy of 100 words.

A Strange Phenomenon at Sea.—Mr. R. E. Harris, commander of the ss. Shahjehan, belonging to the Asiatic Steam Navigation Company, gives an account of a very striking luminous phenomenon, to which he attributes an electrical origin. It occurred on the Malabar coast, during a perfect calm. Mr. Harris says:—"I went on deck, and at once observed a streak of white matter on the horizon bearing S.S.W. I then went on the bridge and drew the third officer's attention to it. In a few minutes it had assumed the shape of a segment of a circle measuring about 45 degrees in length, and several degrees in altitude about its centre. At this time it shone with a peculiar but beautiful milky-whiteness, and resembled (only in a huge mass, and greater luminous intensity) the nebulæ sometimes seen in the heavens. We were steaming to the southward, and as the bank of light extended, one of its arms crossed our path. The whole thing appeared so foreign to anything I had ever seen, and so wonderful, that I stopped the ship just on its outskirts, so that I might try to form a true and just conception of what it really was. Some little time before the first body of light reached the ship, I was enabled with my night glasses to resolve in a measure what appeared to the unassisted eye a hugh mass of nebulous matter. I distinctly saw spaces between what again appeared to be waves of light of great lustre. These came rolling on with ever increasing rapidity till they reached the ship, and in a short time the ship was completely surrounded with one great body of undulating light, which soon extended to the horizon on all sides. On looking into the water, it was seen to be studded with patches of faint, luminous, inanimate matter, measuring about two feet in diameter. Although these emitted a certain amount of light, it was most insignificant when compared with the great waves of light that were floating on the surface of the water, and which were at this time converging upon the ship. The waves stood many degrees above the water, like a highly luminous mist, and obscured by their intensity the distant horizon, and as wave succeeded wave in rapid succession, one of the most grand and brilliant yet solemn spectacles that one could ever think of was here witnessed. In speaking of waves of light I do not wish to convey the idea that they were mere ripplings which are sometimes caused by fish passing through a phosphorescent sea, but waves of great length and breadth, or, in other words, great bodies of light. If the sea could be converted into a huge mirror, and thousands of powerful electric lights were made to throw their rays across it, it would convey no adequate idea of this strange yet grand phenomenon. As the waves of light converged upon the ship from all sides they appeared higher than her hull, and looked as if they were about to envelope her, and as they impinged upon her, her sides seemed to collapse and expand. Whilst this was going on the ship was perfectly at rest, and the water was like a mill-pond. During the last eighteen years I have navigated nearly every little corner of the Asiatic shores from Suez to the north of China and Japan, but never have I witnessed anything at all resembling what I have tried, but fear have not been able, to portray. I have seen many seas beautifully illumined with phosphorus, but in this case there was a total absence of it. No indication of it appeared as the ship divided the water with her stem, nor did any appear in her wake. This point was carefully gone into and discussed at the time, and special observations made at different parts of the ship. After about a half hour had elapsed the brilliancy of the light somewhat abated, and there was a great paucity of the faint lustrous patches which I have before referred to, but still the body of light was great, and, if emanating from these patches, was out of all proportion to their number."

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ANDRE'S ELECTRIC LIGHT FOR MANSIONS.

While the attention of the public is directed to the notorious laboratory of Menlo Park for the advent of the coming electric light which is to astonish the world, and eclipse alike the spirits of gas-shareholders and the dingy flame which yields them their fat dividends, and while it is directed there, thus far at least in vain, a great deal of quiet, successful work is being done and progress made in practical electric lighting, both in England and the Continent. It must be regarded as a fortunate circumstance for our inventors that they are not subjected in this country to the blazonry of the Press, and do not, like Mr. Edison, lose the sweet inspiration of secret working which future success and revelation alone can give. They are not forced to count their chickens before they are hatched, and trumpet forth what they mean to do before they can be sure of doing it. The true development of an invention in seclusion, secresy, and alone can still be followed out. If it is successful a rich reward is earned; while, if it fails, the worker does not incur any opprobrium for announcing results which could not be achieved.

The electric lamp of Professor André has not been often brought before the notice of the public, yet it is a lamp on which the inventor has spent a vast deal of labour and ingenuity, and one which promises to take a high place in the electric lighting of the immediate future. It is a small lamp designed for lighting private dwellings, mines, and factories, and is in this respect unlike the ordinary lamps of Siemens, Rapieff, and Jablochkoff, now in vogue, but it can also be made to give a very intense light. We recently described his first form of the lamp in *The Electrician*, page 174, Vol. III., but its efficiency has been much improved of late by several minor improvements. It may be remembered that it is based on the incandescent principle, and consists of several pencils of carbon enclosed in an air-tight glass cylinder, which forms the globe of the lamp. The pencils are placed vertically, and their points rest on a copper electrode in the bottom of the lamp. When the current is let on these electrified points glow with great brilliance. The light lasts for many hours, because the carbons are very slowly consumed one after another in the carbonic acid gas which the air within the vessel is converted into after a few minutes' burning. Generally speaking, M. André's lamp comes between the incandescent electric lamps of Lodiguin and Sawyer-Mann, which consist of a solid rod of carbon wholly heated by the passage of a current in a glass vessel filled with nitrogen gas, and the incandescent lamps of Regnier and Werdermann, which consist of incandescent carbon points burning free in air. The multiple points, the solid copper electrode for all, the carbonic acid medium, the electro-magnetic regulator, in short, the whole arrangements of the lamp are peculiar to M. André, and it must be confessed that the idea of placing the incandescent points in an atmosphere of carbonic acid, which is so easily formed by the action of the lamp itself, and, at the same time, is so essential to protect the fine carbons from unnecessary waste, is a happy and important one, though not altogether new.

The proof of an invention lies, however, in its practice, and M. André's lamp has now earned a fair title to public consideration. An exhibition of his system of electric lighting for mansions and dwelling houses came off at Stafford House on the evening of January 20, in the presence of the Prince of Wales, the Duke and Duchess of Sutherland, Sir Frederick Leighton, and several other gentlemen. The first experiment was made with six lamps of 75 candle-power each, in circuit with 1,000 yards of cable, and fed by one small Gramme machine; the second was made with 14 lamps of 70 candle-power each, in the same circuit; the third, of 20 lamps of 50 candles each, in a circuit of 500 yards, fed by the same machine; and lastly 36 lamps of 25 candles each, in the same circuit of 500 yards, and fed by the same machine. The power absorbed was from 1-3 to 1-6 horse-power per lamp.

The lantern ceiling of the grand staircase was lighted up brilliantly, clearly showing from below with very fine effect the splendid decorations overhead at a height of from 60 to 80 feet.

The dining rooms, drawing room, and boudoir were also lighted up with large, handsome lamps, draped in white, pink, and yellow tissue paper, which produced a most agreeable, soft, and steady light, and when it was required to illuminate the pictures on the walls these tissues were removed so as to throw the unclouded effulgence of the lamps upon them. His Royal Highness the Prince of Wales was, we believe, greatly pleased with the light, and told Professor André that it was the best display of electric lighting he had yet seen. The apparatus used at Stafford House has now been removed to the country mansion of Mr. Edward Easton, C.E., who is associated with M. André in the exhaustive development of the lamp, and will there be permanently installed as the model, to be shown the public, of André's system of domestic electric lighting. It is, we think, to be regretted that M. André should have chosen so inconvenient a place to exhibit his system, but probably he will also arrange to show it in operation in the metropolis itself.

The new lamp is not, of course, to be confined to dwelling-houses, or fiery mines, but is also especially adapted to mills, manufactories, and other large works. The North Shore Corn Mills, near Liverpool, have also been lighted by them, and the Liverpool Corporation, who last year obtained an Act of Parliament to light the borough of Liverpool by means of electricity, are at present considering its advantages for the purpose of lighting streets.

[The above article was crowded out of our last issue, and since then we have seen an improvement which, to our mind, renders this lamp the best that has, as yet, been invented. This improvement has been made and carried out by the Hon R. Brougham, and will be described and illustrated next week.—Ed. *E.*]

ON A NEW ACTION OF THE MAGNET ON ELECTRIC CURRENTS.

By E. H. Hall, Fellow of the Johns Hopkins University.

Sometime during the last University year, while I was reading "Maxwell's Electricity and Magnetism" in connection with Prof. Rowland's lectures, my attention was particularly attracted by the following passage in Vol. II., p. 144.

"It must be carefully remembered that the mechanical force which urges a conductor carrying a current across the lines of magnetic force, acts, not on the electric current, but on the conductor which carries it. If the conductor be a rotating disc or a fluid it will move in obedience to this force, and this motion may or may not be accompanied with a change of position of the electric current which it carries. But if the current itself be free to choose any path through a fixed solid conductor or a network of wires, then, when a constant magnetic force is made to act on a system, the path of the current through the conductors is not permanently altered, but after certain transient phenomena, called induction currents, have subsided, the distribution of the current will be found to be the same as if no magnetic force were in action. The only force which acts on electric currents is electromotive force, which must be distinguished from the mechanical force which is the subject of this chapter."

This statement seemed to me to be contrary to the most natural supposition in the case considered, taking into account the fact that a wire not bearing a current is in general not affected by a magnet, and that a wire bearing a current is affected exactly in proportion to the strength of the current, while the size and in general the material of the wire are matters of indifference. Moreover, in explaining the phenomena of statical electricity it is customary to say that charged bodies are attracted toward each other, or the contrary, solely by the attraction or repulsion of the charges for each other.

Soon after reading the above statement in Maxwell I read an article by Prof. Edlund, entitled, "Unipolar Induction" (*Phil. Mag.*, Oct., 1878, or *Annales de Chemie et de Physique*, Jan., 1879), in which the author evidently assumes that a magnet acts upon a current in a fixed conductor just as it acts upon the conductor itself when free to move.

Finding these two authorities at variance, I brought the question to Prof. Rowland. He told me he doubted the truth of Maxwell's statement, and had some time before made a hasty experiment for the purpose of detecting if possible some action of the magnet on the current itself, though without success. Being very busy with other matters, however, he had no immediate intention of carrying the investigation further.

I now began to give the matter more attention and hit upon a method that seemed to promise a solution of the problem. I laid my plan before Professor Rowland, and asked whether he had any objection to my making the experiment. He approved of my method in the main, though suggesting some very important changes in the proposed form and arrangement of the apparatus. The experiment proposed was suggested by the following reflection:—If the current of electricity in a fixed conductor is itself attracted by a magnet the current should be drawn to one side of the wire, and, therefore, the resistance experienced should be increased.

To test this theory, a flat spiral of German silver wire was enclosed between two thin discs of hard rubber, and the whole placed between the poles of an electro-magnet in such a position that the lines of magnetic force would pass through the spiral at right angles to the current of electricity.

The wire of the spiral was about $\frac{1}{2}$ millim. in diameter, and the resistance of the spiral was about two ohms.

The magnet was worked by a battery of twenty Bunsen cells, joined four in series and five abreast. The strength of the magnetic field, in which the coil was placed, was probably fifteen, or

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twenty thousand times H, the horizontal intensity of the earth's magnetism.

Making the spiral one arm of a Wheatstone bridge, and using a low resistance Thomson galvanometer, so delicately adjusted as to betray a change of about one part in a million in the resistance of the spiral I made, from October 7th to October 11th inclusive, thirteen series of observations, each of forty readings. A reading would first be made with the magnet active in a certain direction, then a reading with the magnet inactive, then one with the magnet active in the direction opposite to the first, then with the magnet inactive, and so on till the series of forty readings was completed.

Some of the series seemed to show a slight increase of resistance due to the action of the magnet, some a slight decrease, the greatest change indicated by any complete series being a decrease of about one part in a hundred and fifty thousand. Nearly all the other series indicated a very much smaller change, the average change shown by the thirteen series being a decrease of about one part in five millions.

Apparently, then, the magnet's action caused no change in the resistance of the coil.

But though conclusive, apparently, in respect to any change of resistance, the above experiments are not sufficient to prove that a magnet cannot affect an electric current. If electricity is assumed to be an incompressible fluid, as some suspect it to be, we may conceive that the current of electricity flowing in a wire cannot be forced into one side of the wire or made to flow in any but a symmetrical manner. The magnet may *tend* to deflect the current without being able to do so. It is evident that in this case there would exist a state of stress in the conductor, the electricity pressing, as it were, toward one side of the wire.

Reasoning thus, I thought it necessary, in order to make a thorough investigation of the matter, to test for a difference of potential between points on opposite sides of the conductor.

This could be done by repeating the experiment formerly made by Prof. Rowland, and which was the following:—

A disc or strip of metal, forming part of an electric circuit, was placed between the poles of an electro-magnet, the disc cutting across the lines of force. The two poles of a sensitive galvanometer were then placed in connection with different parts of the disc, through which an electric current was passing, until two nearly equipotential points were formed. The magnetic current was then turned on and the galvanometer was observed, in order to detect any indication of a change in the relative potential of the two poles.

Owing probably to the fact that the metal disc used had considerable thickness, the experiment at that time failed to give any positive result. Professor Rowland now advised me, in repeating this experiment, to use gold leaf mounted on a plate of glass as my metal strip. I did so, and, experimenting as indicated above, succeeded, on the 28th of October, in obtaining, as the effect of the magnet's action, a decided deflection of the galvanometer needle.

This deflection was much too large to be attributed to the direct action of the magnet on the galvanometer needle, or to any similar cause. It was, moreover, a permanent deflection, and therefore not to be accounted for by induction. The effect was reversed when the magnet was reversed. It was not reversed by transferring the poles of the galvanometer from one end of the strip to the other. In short, the phenomena observed were just such as we should expect to see if the electric current were pressed, but not moved, toward one side of the conductor.

In regard to the direction of this pressure or tendency as dependent on the direction of the current in the gold leaf and the direction of the lines of magnetic force, the following statement may be made:—If we regard an electric current as a single stream flowing from the positive to the negative pole, *i.e.*, from the carbon pole of the battery through the circuit to the zinc pole, in this case the phenomena observed indicate that two *currents* parallel and in the same direction tend to repel each other. If, on the other hand, we regard the electric current as a stream flowing from the negative to the positive pole, in this case the phenomena observed indicate that two *currents* parallel and in the same direction tend to attract each other.

It is, of course, perfectly well known that two *conductors* bearing currents parallel and in the same direction are drawn toward each other. Whether this fact, taken in connection with what has been said above, has any bearing upon the question of the absolute direction of the electric current it is perhaps too early to decide.

In order to make some rough quantitative experiments a new plate was prepared, consisting of a strip of gold leaf about 2 cm. wide and 9 cm. long, mounted on plate glass. Good contact was ensured by pressing firmly down on each end of the strip of gold leaf a thick piece of brass polished on the under side. To these pieces of brass the wires from a single Bunsen cell were soldered. The portion of the gold leaf strip not covered by the pieces of brass was about 5½ cm. in length, and had a resistance of about 2 ohms. The poles of a high-resistance Thomson galvanometer were placed in connection with points opposite each other on the edges of the strip of gold leaf, and midway between the pieces of brass. The glass plate bearing the gold leaf was fastened, as the first one had been, by a soft cement to the flat end of one pole of the magnet, the other pole of the magnet being brought to within about 6 mm. of the strip of gold leaf.

The apparatus being arranged as above described, on the 12th of November a series of observations was made for the purpose of determining the variations of the observed effect with known variations of the magnetic force, and the strength of current through the gold leaf.

The experiments were hastily and roughly made, but are sufficiently accurate, it is thought, to determine the law of variation above mentioned, as well as the order of magnitude of the current through the Thomson galvanometer compared with the current through the gold leaf and the intensity of the magnetic field.

The results obtained are as follow:—

Current through gold leaf strip. C.		Strength of magnetic field. M.		Current through Thomson galvanometer. c.		$\frac{C+M}{c}$
·0616	...	11420 H	...	·00000000232	...	·303000000000
·0249	...	11240	...	·085	...	·329
·0389	...	11060	...	·135	...	·319
·0598	...	7670	...	·147	...	·312
·0595	...	5700	...	·104	...	·326

H is the horizontal intensity of the earth's magnetism = ·19 approximately.

Though the greatest difference in the last column above amounts to about 8 per cent. of the mean quotient, yet it seems to conclude that, with a given form and arrangement of apparatus, the action on the Thomson galvanometer is proportional to the product of the magnetic force by the current through the gold leaf. This is not the same as saying that the effect on the Thomson galvanometer is, under all circumstances, proportional to the current which is passing between the poles of the magnet. If a strip of copper, of the same length and breadth as the gold leaf, but ¼ mm. in thickness, is substituted for the latter, the galvanometer fails to detect any current arising from the action of the magnet except an induction current at the moment of making or breaking the magnet circuit. It has been stated above that, in the experiments thus far tried, the current apparently tends to move, without actually moving, toward the side of the conductor. I have in mind a form of apparatus which will, I think, allow the current to follow this tendency, and move across the lines of magnetic force. If this experiment succeeds, one or two others immediately suggest themselves.

To make a more complete and accurate study of the phenomenon described in the preceding pages, availing myself of the advice and assistance of Prof. Rowland, will probably occupy me for some months to come.

It is, perhaps, allowable to speak of the action of the magnet as setting up in a strip of gold leaf a new electromotive force at right angles to the primary electromotive force.

This new electromotive force cannot, under ordinary conditions, manifest itself, the circuit in which it might work being incomplete. When the circuit is completed by means of the Thomson galvanometer, a current flows.

The actual current through this galvanometer depends, of course, upon the resistance of the galvanometer and its connections, as well as upon the distance between the two points of the gold leaf at which the ends of the wires from the galvanometer are applied. We cannot, therefore, take the ratio of C and *c* above as the ratio of the primary and the transverse electromotive forces just mentioned.

If we represent by E′ the difference of potential of two points a centimetre apart on the transverse diameter of the strip of gold leaf, and by E the difference of potential of two points a centimetre apart on the longitudinal diameter of the same, a rough and hasty calculation for the experiments already made shows the ratio $\frac{E}{E'}$ to have varied from about 3,000 to about 6,500. The transverse electromotive force E′ seems to be, under ordinary circumstances, proportional to M*v*, where M is the intensity of the magnetic field, and *v* is the *velocity* of the electricity in the gold leaf. Writing for *v* the equivalent expression $\frac{C}{s}$, where C is the primary current through a strip of the gold leaf 1 cm. wide, and *s* is the area of section of the same, we have $E' \propto \frac{M C}{s}$.

—*American Journal of Mathematics.*

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THE CABLE COMPANIES.

Almost all, if not all, the ordinary meetings of the cable companies have now been held, and we may gather the position of the companies from the reports. On the whole there can be no question but that the improvement in trade has shown its effects in increasing the receipts of the companies. There is, however, no room for a *laissez faire* policy, as will be gathered from the excellent address of Mr. Pender, M.P., to the meeting of the Direct United States Company, reported in our last issue. It will be seen that the amount of money invested in cables is about £25,000,000. We quite agree with Mr. Pender when he says that the reserve fund at present held by all the telegraph companies is too small. He and some of his colleagues have consistently, from the moment they first became acquainted with the work of submarine telegraphy, preached the doctrine of a good substantial reserve, with the result that the companies with which they have been longest connected hold the highest position in the market. The Direct United States Company was unfortunate at the commencement of its career, and the weight with which it was then saddled still clings to it, yet the fact that under its present management it has shown great recuperative power, leads us to infer that, should the revival of trade continue, another general meeting will find its position even stronger than now. There is one portion of this address to which we would specially direct attention. It is that relating to tariffs. Many of the unthinking public suppose that any given telegraph line can carry any number of signals per day. Unfortunately, those practically engaged in cable work know the absurdity of this supposition. Let us consider for a moment a suppositious case. The cost of a cable across the Atlantic is about £1,000,000. Taking its life as ten years, that being the value given by Mr. Pender, the reserve should be made at the rate of at least £100,000 a year; really it ought to be greater, so as to include cost of repairs, but if the cost of the latter is reckoned as part of the expenses, the above is required to replace the cable at the end of its life. Suppose a sixpenny tariff, and suppose the rate of sending day and night to be 10 words per minute, the total revenue would be only £131,400 per annum. We doubt if on the average a higher rate of sending than this is obtained, so that it needs little penetration to see the justness of Mr. Pender's remarks. He says:—"We must remember that a submarine cable can only carry a certain number of words, and taking the working time of a cable, it requires three shillings a word to give but a very moderate return upon the invested capital in these Atlantic systems. So far as the Atlantic tariff is concerned, any reduction leading to an increase of messages would not lead to a larger return in money, because at a low rate it would be impossible for a cable to carry the number of words required to make it pay. To carry messages at a low rate additional cables would be required, which, of course, involves additional outlay of capital and reduction of dividends." But we must not only consider that the Direct Company has a cable across the Atlantic; there is also the Anglo-American. These companies have latterly been working with a joint-purse arrangement, and there is no doubt such an arrangement has proved beneficial to both concerns. At a time, however, when it seemed that shareholders would reap some benefit from their investments we find a rival scheme to lay a competing cable. We have more than once referred to this scheme, and the statements made by Mr. Pender fully bear out the opinions we have expressed on the subject. Telegraphy does not admit of undue competition. The capital of the competing scheme has been depreciated till it is now close upon 50 per cent. discount. We have not yet been fully able to understand how any syndicate was able to influence capital that the slightest investigation showed must necessarily be depreciated in value almost immediately. The pending negotiations between the competing companies may or may not be brought to a successful issue. We sincerely trust for all parties concerned that some *via media* of escape may be found, and a fair return for investments obtained.

Looking from the west to the east we notice that, although there is a good deal of competition, there is also a good deal of harmonious working, and that competition is not worked to death in order to fill the pockets of a few speculative capitalists. Time is young yet to speak of the Cape cable, but it has met with one of those accidents to which all cables are more or less liable. The cause of the accident we cannot say, but no time was lost in repairing the cable, and it is satisfactory to know that no difficulty was experienced in effecting these repairs. The method which has been pursued by the management of the Eastern and the Eastern Extension Companies is to be commended. It is almost impossible now for a total break of transmission to appear in these systems. Nearly all the lines are duplicated, some even tripli

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cated, so that should a fault arise there remains an alternative route. Efficiency and speed have still further been increased by duplexing the most important lines, this work having, except in the case of the Anglo-American system, been effected by the Muirhead system. If we are not to be guided by the men who have achieved these successes, by whom should we be guided in this question of tariffs? None of these companies pay exorbitant dividends. Five or six per cent. is all that is obtained, whilst every effort is made to keep the companies on a firm and safe footing. If twenty or thirty per cent. were being realised, there would be some ground for an outcry against the system, but whilst the facts are what they are we shall in season and out of season support those who are endeavouring not only faithfully to serve the public, but also as faithfully to consider and acknowledge the duty they owe to the shareholders.

CONTRIBUTIONS TO A PHYSICAL THEORY OF ELECTRICITY.

BY DESMOND G. FITZGERALD.

(CONTINUED FROM P. 178.)

In order to be able to calculate, by means of our equations for v, the molecular velocity in the case of any conductor conveying a constant current, it is necessary either that we should be able to express f (*i.e.* the true electromotive force in action) in terms of the unit of force belonging to the absolute system we employ (viz., in this case the F P S abs. system), or that we should find an equation for the period (T) of variable motion which does not involve the values v or f. We have, therefore, now to investigate whether that value which is generally termed by electricians "electromotive force," and which is expressed by the symbol E, really does express the force producing the molecular motion which results in electrical conduction, or whether this force varies as some function of E.

Now, it is well known that *electrical work*, necessarily equal to fs, or to fv when *time* is unity, is expressed by the formula

$$\mathrm{E\,I}\,k = \frac{\mathrm{E}^2}{R}k = \mathrm{I}^2 R\,k,*$$

in which $k = \cdot7375$ when the work is expressed in foot-lb. If, therefore, the work is to be expressed in absolute F P S units, the constant k becomes $\cdot7375 \times 32{\cdot}2 = 23{\cdot}74$; and we have, taking unit time,

$$\frac{\mathrm{E}^2}{R} \times 23{\cdot}74 = fv \text{ abs. F P S units of work,}$$

$$\mathrm{E}^2 = \frac{fvR}{k}, \text{ and}$$

$$\mathrm{E} = \sqrt{fv} \times \sqrt{\frac{R}{k}},$$

$$\text{or } \mathrm{E} \propto \sqrt{fvR}.$$

It will be seen that $R \propto \frac{\mathrm{E}^2}{vf}$; and, consequently, when E and f are constant, R varies inversely as v, or $R \propto \frac{1}{v}$. In this case, therefore, the products $v\,R$ and $\sqrt{v\,R}$ are constant; and we may write

$$\mathrm{E} \propto \sqrt{f}.$$

This expression for E also applies when v and R disappear, as in cases of electrostatic charge. (*Vide* experimental verification below.)

But, when E and f are variable, $\sqrt{v\,R} \propto \frac{\mathrm{E}}{\sqrt{f}}$, a quotient that will be constant only if $\mathrm{E} \propto \sqrt{f}$ in this case also.

Now, there is a puzzling complication in the action, at the terminals of a conductor, of a force producing the motion of its molecules which results in conduction; and this complication has prevented the recognition, on the part of electricians, of the above relation. Substituting in our original equation the value $\frac{l}{d^2}$ for R, we have

$$\frac{\mathrm{E}^2 d^2}{l} \propto fv, \text{ and } f \propto \frac{\mathrm{E}^2 d^2}{l};$$

whence it appears that f varies as E^2, and also directly as d^2 and inversely as the product $l\,v$.

Let us, by way of hypothesis, assume that, in a conductor constituted by a single line of molecules, a current would be simply proportional to the velocity of motion of these molecules; then, velocity being constant, the current would vary as the number of such lines of molecules, or as $d^2 = \frac{m}{l}$. According to this assumption, the accuracy of which appears very probably form a physical point of view, we have

$$\mathrm{I} \propto v\,d^2, \text{ and } v \propto \frac{\mathrm{I}}{d^2} = \frac{\mathrm{E}}{l} \left(\text{since } \mathrm{I} \propto \frac{\mathrm{E}\,d^2}{l} = \frac{\mathrm{E}}{R}\right).$$

Then the above ratio for f becomes

$$f \propto \frac{\mathrm{E}^2 d^2}{l} \times \frac{l}{\mathrm{E}} = \mathrm{E}\,d^2;$$

and we have

$$\mathrm{E} \propto v\,l = \frac{f}{d^2};$$

or (multiplying together the two values, and taking the square root of the product),

$$\mathrm{E} \propto \frac{\sqrt{f v\,l}}{d} = v\,l.$$

Consequently,

$$\frac{\sqrt{f}}{d} \propto \sqrt{v\,l}; \text{ and } f \propto l\,d^2\,v = m\,v.$$

According to this view, the force f is not, like E, a value constant, under certain conditions, for each electromotor, but varies as the mass of the conductor and as the molecular velocity. In this circumstance, probably, may be found an explanation of the fact that, although the electrostatic value of E is undoubtedly the square root of f, the electro-dynamic value of E appears to vary as f; so that electrians regard this value as that of the *force* in action, and term it, accordingly, *electromotive force*.

Adopting, in our original equation, the new values for f, E and v, we have

$$\frac{\mathrm{E}^2 d^2}{l} \propto l\,d^2\,v^2 = m\,v^2,$$

$$\frac{f^2}{d^2\,l} \propto fv,$$

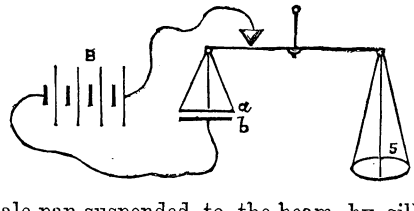
$$\text{and } \frac{\mathrm{E}^2 d^2}{l} \propto \frac{f\mathrm{E}}{l} = m\frac{\mathrm{E}^2}{l^2}.$$

And, to express *current*, we have

$$\mathrm{I} \propto \frac{\mathrm{E}\,d^2}{l} = \frac{\sqrt{fv}}{\sqrt{R}} = v\,d^2 = \frac{m\,v}{l}.$$

In any equivalent concrete expressions the numerical constant would, of course, vary according to the nature of the mass m, *i.e.*, according to its specific resistance.

An old and simple experiment shows conclusively that the electrostatic force brought into action by an electromoter, under given conditions, varies exactly as the *square* of what is termed its "electromotive force." In the figure, a represents a very light disc of aluminium, connected by means of fine wires with the scale beam of the "electrostatic balance," and adjusted by means of a stop at a very small and constant distance from a metallic plate, b, of the same diameter,



and s is a scale-pan suspended to the beam by silken threads. Adjustment having been made so that a very slight force of attraction between a and b will cause these plates to come into contact, a small quantity of fine dry sand (determined by a preliminary experiment) is placed in the pan s, and a battery, B, having the "electromotive force of, say, 100 volts, is connected with its poles respectively in contact with the plates a and b.

* In order to distinguish the artificial "resistance" of Prof. Ohm, varying, with a given material at a given temperature, as $\frac{l}{d^2}$, from the true resistance which necessarily is equal to the force f in action, I express the former by the symbol R in italics.

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Portions of the sand are then removed from *s* until the plates move into contact. They are then separated, and the quantity of sand in *s* is very gradually augmented until the attractive force between *a* and *b* is exactly balanced. The sand having been weighed, a fourfold quantity may be placed in *s*, and this will exactly balance the attraction between *a* and *b* when a battery of double "electromotive force" is substituted for the former battery. And in all cases the electrical force, which is here measured against that of gravity, will be found to vary as the *square* of the so-called electromotive force.

(TO BE CONTINUED.)

ON THE INFLUENCE OF ELECTRIC LIGHT UPON VEGETATION, AND ON CERTAIN PHYSICAL PRINCIPLES INVOLVED.

By C. William Siemens, D.C.L., F.R.S. Received March 1, 1880.

Although, according to Ste. Claire Deville, the dissociation of CO_2 and H_2O at atmospheric pressure commences at a temperature not exceeding 1,200° C., the reverse action, namely, combustion, continues to be sufficiently active to increase the heat of a flame until a temperature of 2,200° C. is reached, of which the Deville oxygen blast and the regenerative gas-furnace furnish examples.

In the working out of a process, by means of which steel and fused iron are produced in large masses on the open hearth of the regenerative gas-furnace, I have had frequent opportunities of observing the utmost limit of temperature practically attainable by means of the combustion of carbonaceous substances. The heat of that furnace is not dependent upon a blast or upon chimney draught, and the pressure within the furnace balances the external atmospheric pressure so completely that the large working doors may be opened occasionally for inspecting the metal. On these occasions it may frequently be observed that serrated clouds of highly heated combustible gases pass through the furnace chamber (as may be seen through obscured or coloured glasses) without suffering apparently any diminution through contact with an excess of heated oxygen, showing that the limit of furnace heat, or the point of complete dissociation, has been nearly reached.

When thus brought face to face with the utmost limit of heat attainable by combustion, it is surprising how slight is the inconvenience (in the absence of heated matter flying about) experienced in approaching the open furnace, and how much higher must be the temperature of the sun or of the electric arc when the effects of distant radiation suffice to break up compounds such as nitrate of silver in a few seconds. Some years ago I undertook certain experimental inquiries having for their object to study the effect of radiant energy upon the ordinary products of combustion of CO_2 and H_2O as presenting this in an extremely rarefied condition to solar and electric radiation, which inquiries were not, however, carried far enough to furnish absolute results. They served us, however, for a stepping stone to the subject of my present communication.

The vast development of vegetation proves that dissociation is accomplished freely within the leaf-cells of plants, in which both water and carbonic acid are broken up in order that chlorophyl, starch, and cellulose may be formed. It is well known that this reaction depends upon solar radiation; but the question may fairly be asked whether it is confined to that agency, or whether other sources of light and heat, which in common with the sun exceed the temperature of dissociation, may not be called into requisition, in order to continue the action of growth, when that great luminary has set or is hidden behind clouds?

About two years ago I mentioned to Sir Joseph Hooker, then President of the Royal Society, that I thought the electric arc might be found sufficiently powerful to promote vegetation, and that I should be willing to undertake some experiments on the subject if he could give me any hope of confirmative results. Sir Joseph Hooker gave me sufficient encouragement to induce me to follow up the subject, and I have since that time gradually matured a plan for conducting the experiment. Operations were commenced only at the beginning of the year, and although the results are necessarily incomplete, they are nevertheless sufficiently positive and remarkable to make them perhaps acceptable to the Royal Society as a preliminary communication on the subject. I was induced to look for interesting results in these experiments on account of the great abundance of blue and actinic rays in the electric arc, upon which its value in photography depends. In experimenting with powerful electric lamps for illuminating purposes I have been struck, moreover, by the action produced upon the skin, which is blistered, without the sensation of excessive heat at the time, an effect analogous to that produced by solar rays in a clear atmosphere.

Effect of Radiant Energy on Plants.

The apparatus which has been put up at Sherwood consists—1. Of a vertical Siemens dynamo-machine, weighing 50 kilos., with a wire resistance of 0·717 unit on the electro-magnets. This machine makes 1,000 revolutions a minute, it takes 2 horse-power to drive it, and develops a current of 25 to 27 Webers of an intensity of 70 volts. 2. A regulator or lamp, constructed for continuous currents, with two carbon electrodes of 12 millims. and 10 millims. diameter respectively. The light produced is equal to 1,400 candles measured photometrically. 3. A motor, which at present is a 3 horse-power Otto gas engine, but which it is intended to supersede by a turbine to be worked by a natural supply of water, at a distance of about half a mile from the house.

Experiments on Effect of Electric Light on Plants.

My object in making these experiments was to ascertain whether electric light exercised any decided effect upon the growth of plants. For this purpose I placed the regulator in a lamp with a metallic reflector, in the open air, about 2 metres above the glass of a sunk melon house. A considerable number of pots were provided, sown and planted with quick-growing seeds and plants, such as mustard, carrots, swedes, beans, cucumbers, and melons. The plants could then be brought at suitable intervals under the influence of daylight and electric light, without moving them, both falling upon them approximately at the same angle. The pots were divided into four groups.

1. One pot of each group was kept entirely in the dark.
2. One was exposed to the influence of the electric light only.
3. One was exposed to the influence of daylight only.
4. One was exposed successively to both day and electric light.

The electric light was supplied for six hours, from 5 to 11 each evening, all the plants being left in darkness during the remainder of the night.

In all cases the differences of effect were unmistakable. The plants kept in the dark were pale yellow, thin in the stalk, and soon died. Those exposed to electric light only showed a light green leaf, and had sufficient vigour to survive. Those exposed to daylight only were of a darker green and greater vigour. Those exposed to both sources of light showed a decided superiority in vigour over all the others, and the green of the leaf was of a dark rich hue.

It must be remembered that, in this contest of electric against solar light, the time of exposure was in favour of the latter in the proportion of nearly 2 to 1, but all allowance made, daylight appeared to be about twice as effective as electric light. It was evident, however, that the electric light was not well placed for giving out its power advantageously. The nights being cold, and the plants under experiment for the most part of a character to require a hot moist atmosphere, the glass was covered very thickly with moisture, which greatly obstructed the action of the light, besides which, the electric light had to pass through the glass of its own lamp.* Notwithstanding these drawbacks, electric light was clearly sufficiently powerful to form chlorophyl and its derivatives in the plants. It was interesting to observe that the mustard-seed stem, when placed obliquely, turned completely towards the light in the course of two or three hours, and that cucumber and melon plants were affected in the same way, though at a slower rate. The cucumber and melon plants which have been exposed to both day and electric light have made great progress, and my gardener, Mr. D. Buchanan, says that he could not have brought on the latter, without the aid of electric light, during the early winter. Some of these commenced to blossom on the 14th of February.

These preliminary trials go to prove that electric light can be utilised in aid of solar light by placing it over greenhouses, but the loss of effect in such cases must be considerable. I, therefore, directed my observations, in the next place, to the effect of electric light upon plants, when both were placed in the same apartment. A section of the melon house, already referred to (7′ 3″ × 3′ 3″, 2·21 m. × 0·19 m.), was completely darkened by being covered in with thick matting, and was whitewashed inside. The electric light was placed over the entrance door, and shelves were put down, in a horse-shoe form, to receive the pots containing the plants to be exposed to the action of electric light, the plants being placed at distances from the lamp varying from 0·5 metre to 2 metres. Upon the first occasion of trying the naked electric light in this manner, some of the plants, and especially some melon and cucumber plants, from 20 centims. to 40 centims.

* Professor Stokes has shown, in 1857, that the electric arc is particularly rich in highly refrangible invisible rays, a circumstance which seems to point to a great loss on passing those rays through glass.

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in height, which were within a metre distance from the lamp, commenced to suffer; those leaves which were directly opposite the light turning up at the edges and presenting a scorched appearance. On subsequent nights, therefore, the stands were so arranged that the distance of the plants from the light varied from 1·5 metres to 2·3 metres. The plants under experiment were divided into three groups; one group was exposed to daylight alone, a second similar group was exposed to electric light during eleven hours of the night, and were kept in the dark chamber during the daytime, and the third similar group was exposed to eleven hours' day and eleven hours' electric light. These experiments were continued during four days and nights consecutively, and the results observed are of a very striking and decisive character as regards the behaviour of such quick-growing plants as mustard, carrots, &c. The experiment was unsatisfactory in this one respect, that during the third night the gas-engine working the dynamo machine came to a standstill, owing to a stoppage in one of the gas channels, and thus more than half the electric light influence that night was lost to the plants. But, notwithstanding this drawback, the two groups of plants showed unmistakably the beneficial influence of electric light. The plants that had been exposed to daylight alone (comprising a fair proportion of sunlight) presented their usually healthy green appearance; those exposed to electric light alone were in most instances of a somewhat lighter, but, in one instance, of a somewhat darker hue than those exposed to daylight; and all the plants that had the double benefit of day and electric light far surpassed the others in darkness of green and vigorous appearance generally. A fear had been expressed that the melon and cucumber plants which had been scorched by excess of electric light on the first evening would droop or die if further exposed to that agency; but I insisted upon their being placed within the influence of the electric light, at a distance from it exceeding 2 metres, and all of them have shown signs of recovery, throwing out fresh leaves and pearls of moisture at their edges. A pot of tulip buds was placed in this electric stove, and the flowers were observed to open completely after two hours' exposure.

One object I had in view in this experiment, was to observe whether the carbonic acid and nitrogenous compounds produced within the electric arc exercised any deleterious action upon the plants. All continuous access of air into the stove was closed, and in order to prevent excessive accumulation of heat, the stove pipes were thickly covered with matting and wet leaves. But although the access of stove heat was thus virtually stopped, the temperature of the house was maintained throughout the night at 72° F., proving that the electric lamp furnished not only a supply of effective light, but of stove heat also. No hurtful effect was moreover observed on the plants from the want of ventilation, and it would appear probable that the supply of pure carbonic acid resulting from the complete combustion of the carbon electrodes at high temperature, and under the influence of an excess of oxygen, sufficed to sustain their vital functions. If the nitrogenous compounds which Professor Dewar has shown to be developed in the electric arc were produced in large quantities, injurious effects upon the plants must undoubtedly ensue, but it can be shown that in a well-conditioned electric lamp, with a free circulation of air round the carbon electrodes, the amount of these products is exceedingly small, and of a different nature than is produced in a confined space. They could not indeed be perceived by their smell in the stove, when all ventilators were closed, and no injurious effects from them have hitherto been observed in the plants.

These experiments are not only instructive in proving the sufficiency of electric light alone to promote vegetation, but they also go to prove the important fact that diurnal repose is not necessary for the life of plants, although the duration of the experiments is too limited perhaps to furnish that proof in an absolute manner. It may, however, be argued from analogy, that such repose is not necessary, seeing that crops grow and ripen in a wonderfully short space of time in the northern regions of Sweden and Norway, and Finland, where the summer does not exceed two months, during which period the sun scarcely sets.

The next step in the course of these experiments was to remove the electric lamp into a palm house, constructed of framed glass, which was 28ft. 3in. long, 14ft. 6in. wide, and averaging 14ft. 6in. (8·62m. + 14·42m. + 4·42) in height. In the centre of this house a banana palm, and a few other small palm trees are planted, the sides of the house all round being occupied with a considerable variety of flowering plants. The electric light was fixed as high as practicable at the south corner of the house, in order that its rays might fall upon the plants from a direction and at an angle coincident with those of the sun during the middle of the day. A metal reflector was placed behind the lamp in order to utilise the electric rays as much as possible. Along the eastern side of the house are some young vines, having their roots in a bed outside. Three pots of nectarine plants, just beginning to bud, were placed on the floor at various distances from the electric light, and also some rose plants, geraniums, orchids, &c. The temperature of the house was maintained at 65 F., and the electric lamp was kept alight from 5 p.m. to 6 a.m., for one week, from February 18th to February 24th, excepting Sunday night. The time was hardly sufficient to produce very striking effects, but all the plants continued to present a healthy appearance. Of three Alicante vines, the one nearest the electric light made most progress, and the same could be said of the nectarines and roses. It was observed that other plants, such as geraniums, continued to exhibit a vigorous appearance, notwithstanding the heat of the place. The electric light appeared to impart the vitality necessary to prevent a collapse of the organism through excessive temperature. This experiment is of importance in showing that the electric light if put into conservatories or greenhouses does not injure the plants, but rather improves their appearance and growth. The leaves assume a darker and more vigorous appearance, and it seems that the colouring of the flowers becomes more vivid, but a further period of time is necessary to establish this observation absolutely. The effects producible by electric light in conservatories is very striking, owing to the clear definition of form and colour produced, far exceeding that of ordinary daylight.

No further results of any particular interest could be expected from a continuance of this experiment, and I decided to try the effect of electric light as a means of promoting growth in the open air and under glass at the same time. The regulator was put back into its first position, 2 metres above the ground, with a sunken melon house on one side, and a sunken house containing roses, lilies, strawberries, and a variety of other plants on the other. The space of ground between these (about 1 metre broad and 7 metres long) was covered with boxes sown with early vegetables, including mustard, peas, beans, and potatoes; and in order to prevent cold winds from injuring the plants low protecting walls were put up across the openings of the passage between the two houses. The effect of electric light could thus be observed at the same time upon the melon and cucumber plants in the one house, upon the roses, strawberries, &c., at an inferior temperature in the other, and upon the early vegetables unprovided with covering.

Some weeks must elapse before any absolute results can be given, but growth is evidently promoted under all these various circumstances. In order to test this clearly, a portion of the plants both under glass and in the open air are shaded from the electric light without removing them from their position of equal temperature and exposed to solar light during daytime. The effect upon the flowering plants is very striking, electric light being apparently more efficacious to bring them on than daylight. Although the amount of heat given off from the electric arc is not great compared with a gas flame (giving off its products of combustion), yet the rays of intense heat of the arc counteract that loss of heat by radiation from the leaves into space, which during a clear night causes hoar-frost. For this reason I expect that electric light may be usefully employed in front of fruit walls, in orchards and in kitchen gardens, to save the fruit-bud at the time of setting; and in this application electric light will probably be found a useful agent not only to promote rapid growth, but to insure a better yield of fruit. Experience alone can determine absolutely the effect of electric light upon the ripening of delicate fruit, but considering its evident power to form chlorophyl, there seems no reason to suppose that its action would not also in this case resemble that of the sun, and that saccharine matter, and more especially the aromatic constituents, would be produced. In this country solar light is too often found insufficient to ripen the fruit or even the wood of fruit trees during the short summer months; and I believe that electric light will be found a most useful auxiliary to solar light to effect the production of ripe and aromatic fruit both under glass and in the open air.

Estimated Cost of Electro-Horticulture.

A very important question is that of the cost of electro-horticulture. This will depend in a great measure upon the cost of the fuel or other source of energy, and upon the scale of application. To work only one electric lamp by means of a small steam or gas engine is expensive both in fuel and in cost of attendance. If steam-power has to be resorted to, an engine of sufficient size should be employed to give economical results per horse-power of energy produced, and the electric arc should be of sufficient brilliancy to give a good effect for the power expended. Experience in electric illumination has established a form and size of machine, both convenient and suitable for the attainment of economical results, viz., the medium dynamo-electric machine, which, if applied to a suitable regulator, produces fully 6,000 candle-power of diffused light with an expenditure of 4 horse-power.

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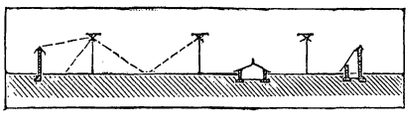
The experiments before given show that the most effective height at which to place the naked electric light of 1,400 candle-power is about 2 metres. By providing a metallic reflector, and thus throwing the major portion of the upward rays down upon the surface to be illuminated that height may be taken at 3 metres. If the electric arc employed was equal to 6,000 candles, the height would be $\frac{\sqrt{6,000}}{\sqrt{1,400}} \times 3 = 6{\cdot}2$ metres, at which such an electric light should be fixed under the protection of a tin plate or other reflector. In operating upon an extended surface several lamps should be placed at such distances apart, as to make the effect over it tolerably uniform. The effect of radiation would be equally distributed over the ground if the radiating centres were placed at distances apart equal to double their height above the ground; for under these circumstances a square foot of surface mid-way between them would receive from each centre one half the number of rays falling upon such a surface immediately below a centre. A plant at the intermediate point would, however, have the advantage of presenting a larger leaf surface to the two sources of light; and in order to compensate for this advantage, the light centres may be placed considerably further apart, say at distances equal to three times their elevation, or 18 metres. Nine lights so placed would cover an area 54 metres square, or just about $\frac{3}{4}$ acre. If this space was enclosed with a high fruit wall (as shown with the lamp centres marked in the accompanying sketch), this will also get the full benefit of electric



radiatiation, and would serve at the same time to protect the plants from winds. Protection against injury from this latter cause might be further carried out with advantage by following plan adopted (with excellent results I believe) by Sir William Armstrong, that of subdividing the area under forced cultivation by vertical partitions of glass.

The engine-power necessary to maintain this radiant action would be $9 \times 4 = 36$ horse-power, involving the consumption of $36 \times 2\frac{1}{2} = 90$lb., of fuel per hour, or say, for a night of twelve hours (with an allowance of 40lb. for getting up steam) 10 cwt., which, at sixteen shillings per ton, would cost eight shillings. This expenditure would not include, however, the cost of carbons and of an attendant, which would probably amount to another eight shillings, making a total of sixteen shillings. If, however, an engine can be found doing other descriptions of work during the day time, the cost of steam-power and attendance for the night work only would be considerably reduced. In the calculation just given, I have assumed the employment of fuel for the production of mechanical energy, whereas the question will assume a totally different aspect if natural sources of power, such as waterfalls, can be made available within the reasonable distance of half a mile. The expenditure for energy will, in that case, be almost entirely saved, and that of attendance be greatly diminished, and under such circumstances it seems probable that electro-horticulture may be carried out with considerable advantage.

The experiments furnish proof that the management of the electrical apparatus presents no particular difficulty, as the gas-engine, dynamo machine, and regulator have been under the sole management of my head gardener, Mr. D. Buchanan, and his son, an assistant gardener. The regulator requires no attention beyond the replacement of carbons every four or five hours, which period may easily be increased to twelve hours by a slight modification of the lamp.

Conclusions.

The experiments seem to lead to the following conclusions:—

1. That electric light is efficacious in producing chlorophyl, in the leaves of plants, and in promoting growth.

2. That an electric centre of light, equal to 1,400 candles, placed at a distance of 2 metres from growing plants, appeared to be equal in effect to average daylight at this season of the year, but that more economical effects can be attained by more powerful light centres.

3. That the carbonic acid and nitrogenous compounds generated in diminutive quantities in the electric arc, produce no sensible deleterious effects upon plants enclosed in the same space.

4. That plants do not appear to require a period of rest during the twenty-four hours of the day, but make increased and vigorous progress if subjected during daytime to sunlight and during the night to electric light.

5. That the radiation of heat from powerful electric arcs can be made available to counteract the effect of night frost, and is likely to promote the setting and ripening of fruit in the open air.

6. That while under the influence of electric light plants can sustain increased stove heat without collapsing, a circumstance favourable to forcing by electric light.

7. That the expense of electro-horticulture depends mainly upon the cost of mechanical energy, and is very moderate where natural sources of such energy such as waterfalls can be made available.

Since writing the above my attention has been drawn to an article in *Nature*, 29th January, 1880, giving interesting observations by Dr. Schübeler, of Christiana, on "The Effect of Uninterrupted Sunlight on Plants in the Arctic Regions." These observations fully confirm the conclusion indicated by my experiments with electric light. Not only are plants able to grow continuously, according to Dr. Schübeler, but when under the influence of continuous light they develop more brilliant flowers and larger and more aromatic fruit than under the alternating influence of light and darkness, whereas the formation of sugar appears to be dependent chiefly upon temperature.

It would follow from these observations, that with the aid of stoves and electric light, fruit, excelling both in sweetness and aroma, and flowers of great brightness, may be grown without solar aid. Dr. Schübeler mentions that in removing an Acacia plant from the dark, and placing it under the influence of the arctic midnight sun, the leaves opened slowly, and it is interesting to observe that the same effect took place when an Acacia Lophantha was placed (in the open air) under the influence of my midnight lamp.

THE SOCIETY OF TELEGRAPH ENGINEERS.

At the meeting on Wednesday, March 10th, a paper was read "On Some Recent Improvements in Electric Light Apparatus," by Alexander Siemens, M.S.T.E.

The attention which the general public has of late paid to the controversy of Electricity *v.* Gas as an illuminating agent, has induced a good many people to devote their time and attention to the subject. The apparatus used for the production of electric light have undergone a good practical test, and as a result it has been proved that dynamo machines, as well as alternate current machines, can be entrusted to the care of ordinary attendants, who know how to deal with machinery generally. With the regulators or lamps, not quite so satisfactory results have been obtained, but great progress has been made in those lamps in which the light is emitted by a voltaic arc, and in which the electrodes, usually carbons, are placed end to end. The gradual development from a complicated clock-work lamp to simple mechanisms is illustrated by some lamps representing the types manufactured by Messrs. Siemens Brothers.

As regards the cost of the light, it is possible to produce a light of 6,000 candle power by continuous currents for 7½d. per hour, by alternate currents for 2s. 7d. per hour, when the machines are driven by a gas engine; or for 5d. and 2s. 1d. respectively when a steam engine is employed, gas light of the same power costing 4s. 10d. per hour.

The cost of the electric light applied for practical purposes was:—In the Albert Hall £1 10s. 6d. per night, against £4 7s. 6d. for gas, the amount of gas saved being measured by the meter.

At Blackpool six 6,000 candle lights cost per night of five hours £3 6s. 10d., and gas giving the same amount of light would cost £7 5s.

At the British Museum, the lights were used during 360 hours at a cost of £108 1s. 4d., including fuel, carbons, attendance, and repairs, or 6s. per hour, for a light of 18,800 candles, which produced by gas would cost about 15s. per hour.

The electric light may be said, therefore, to have left the experimental stage, and will soon be regarded as one of the necessaries of civilisation.

At the close of the paper, the President, Mr. W. H. Preece, asked that a vote of thanks should be given to the author for his admirable paper. This was accorded unanimously, and in the discussion which followed other gentlemen described lamps invented by them. Mr. Crompton described his lamp, which is simple of its kind, and when tried gave a brilliant light. We hope to describe and illustrate this lamp in a future number. Mr. Hinricks exhibited and described his lamp, which we noticed in Vol. III., p. 201.

M. André briefly described his lamp, which is mentioned in another column, also the improvements of Mr. Brougham. Another lamp, in which carbon plates, or discs, were used, was briefly explained, and the discussion was adjourned to Wednesday, March 24, 1880.

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A PROBATIONER'S EXPERIENCE.

TO THE EDITOR OF THE ELECTRICIAN.

(CONCLUDED FROM PAGE 188.)

I could go on to say a great deal about the various little incidents which happen from time to time to relieve the slightest suspicion of monotony in the work, such as a thunderstorm occurring and the lines being put to earth, which the probationer may learn how to do; the grand crush of work when quadruplex or duplex is going, and the endeavours to prevent any stoppage or accumulation of messages; or possibly a breakdown, and the consequent testing, &c., in all of which he will doubtless find himself wanted to bear a hand if he be willing and ready. However, I am afraid I have already been somewhat verbose, and, as I have not yet said my say, will conclude the practical part, and turn to the general life, pleasures, and enjoyments which a probationer may, if he likes, take his share in at P.K.

The station house is situated in a little valley running down to the sea shore, and terminating in the Bay of Porthcurnow, or Sandy Bay (though as a matter of fact I believe the beach to be composed principally of broken shells); the wind may blow a hurricane, but it will scarcely be felt in the sheltered valley. The view out to sea is a pretty one, embracing as it does the famous Logan Stone and Castle Peak on the left, towering out of the blue waters, whilst in the far distance may be seen the Lizard, with its two lighthouses. The horizon is rarely without some ship or fishing boat visible, and sometimes quite a fleet of Penzance boats may be seen working out seawards to the fishing grounds, whilst occasionally a large steamer enters Mount's Bay to communicate with Penzance. Besides the sea view nothing much can be seen from the house, owing, as might be expected, to its being situate in a valley, but climb the hill on either side, and you get splendid views of some of the finest coast scenery to be seen anywhere in the United Kingdom, I suppose.

Should you feel inclined for a walk you have quite an *embarras de richesse*; on the one side you may go to the Land's End by road or by the coast—the latter you will probably choose if you have an eye for scenery; on your way you will notice innumerable quaint distortions of the cliffs, which may be made to resemble almost anything, according to the fancy of the person; you may see Punch's head, as like as two peas to that worthy personage's portrait as given in the weekly paper bearing his name; or you may look with something of awe down the "Funnel Hole." Should you feel disposed you may stop in your walk to puzzle over quaint Cornish names, such as Tol-Pedin-Pen-with, or halt at the village of Porthgwherra (I must pray to be excused the spelling) for a chat with the fishermen, from whom you may learn a great deal that you did not know before, and be initiated into the mysteries of Cornish lingo; or, should you feel inclined, you may place yourself on a rocky headland, and, whilst you drink in deep draughts of health, may watch the gulls wheeling a hundred feet below, or the numerous vessels passing and repassing close in to the coast, from the stately trooper to the humble billyboy, and unless you be uncommon hard to please, you will scarcely weary of rambles like this, be they repeated for weeks together.

Should you choose the opposite direction you may visit the Logan Stone, nay more, you may rock it should you feel inclined; and if you wish to prove yourself absolutely regardless of life and limb, and amaze the numerous cockneys who flock to this spot all the summer and autumn through, you may climb to the top of the "Castle Peak," and feel very glad to get down again in safety. *En passant*, I may mention that rumour has it that a young fellow, a probationer at P.K., once stood on his head on the top of the peak. If this be true, he must indeed have had nerves to be coveted, for I have got as far as sitting on the top, and have heard of young fellows who have stood erect there, and can only say that it required some nerve to do that, let alone reversing the order of things so far as to stand on one's head.

And here if you want to hear most of the very numerous legends concerning smugglers' caves, &c., let me commend you to the care of "Old Jeff," guide-in-chief to the Logan Rock, should that ancient individual be yet alive.

Then there are the mines of St. Just to be visited, &c.; in fact, the lover of walking will find himself every way suited here, evidence of which may be had in the numbers of tourists who constantly visit this part of the country. If you should fancy the sea, however, in preference to the land, the Porthgwherra fishermen are always ready to take you out for next to nothing in the shape of remuneration, and there is some excellent fishing to be had. And whilst I am talking of the sea it may not be amiss to mention the bathing, which can be had to perfection, and the station house being only some two or three hundred yards from the shore, it is easy enough to run down in a morning for a dip before breakfast and work. Bathing, too, can be indulged in up to quite late in the year, owing to the mildness of the climate, frost being almost unknown, and snow a rarity.

There is some good fun to be got with a gun both with rabbits and seabirds, whilst snipe and woodcock can also be got, I believe. But as I might go on for hours dilating on the beauties of the country, let me sum up by saying that, in my opinion, it is as good a place for young fellows as could well be found in or out of the United Kingdom. Whether one has a taste for botany, conchology, natural history, geology, or mineralogy, here he will be certain to find all that he could wish for; indeed, Porthcurnow beach is celebrated for its shells and for the rarities of sea life which are occasionally found on it, some of which, if I am not mistaken, have ere now found a place in the British Museum, having been contributed by members of the P.K. Staff. Again, if our probationer be athletic, he can join the football or cricket club, according to the time of year, or he may train for the sports, which the company are always willing to sanction, and at which he can disport himself before the *elite* and beauty of Penzance, who honour the occasion by their presence.

Let us go indoors, however, and take a look round. Here, again, we find all that can make life pleasant and agreeable. Each member of the establishment has a separate sleeping room, which is furnished by the company, and with the arrangement of a picture or two can be turned into a most pleasant little room; then there is the mess room, reading room, library, and billiard room.

Those who like books will find a capital lot of all sorts in the library, novels, travels, scientific works, and others, besides which there are the papers of the day. The company also provide a capital piano, and as a great many of the young fellows can play, this is an inexhaustible fund of amusement, and many is the *impromptu* concert I have assisted at. Then for those who care for it there is the billiard table, also provided by the company, and which you can use for a mere nominal sum—if I recollect rightly, 2d. a game, or in the case of pool, &c., 1d. each person—the proceeds being kept in a box placed in the room, and going towards repairs, &c.

In fact, Sir, the fellow who finds time hang heavy on his hands in summer or winter at Porthcurnow has himself to thank for it, and will find himself dull all his life long where'er he be.

With regard to meals, there are three. Breakfast, beginning at 7, for those on morning duty, and continuing till 9 or thereabouts, and for which you have good plain food, well cooked, and as much as you can want. Should you require any little extras, such as bacon and eggs, &c., you can have them for the ordering at a very reasonable charge. Then comes dinner at 3, for the evening duty clerks, and again at 4, for those who have just come off morning duty. This consists of joints, vegetables, and pudding. I forgot to mention, also, that at 12 there is lunch, for those who want it, of excellent bread and butter—and such butter, Sir, as I have not tasted since I left P.K.—and cheese. At 7 there is tea—same as breakfast. Those on evening duty also have supper provided for them, similar to the lunch. Now, Sir, I do not think any one need starve on such fare—in fact, so far from this being the case, if you notice a boy just come to Porthcurnow, and take another look at him a month or so afterwards, you cannot fail to notice a decided change for the better in his looks; he is brown, ruddy, and as healthy-looking as he can be. Of course, there are exceptions to this—some fellows are and always will be sickly-looking, that is not the company's fault, but I assert without hesitation that a month at P. K. puts new life into all but such exceptions.

In my time we could obtain a glass of beer with our lunch and dinner, if we cared for it and could afford the money, for this was included in the extras; but, as a rule, I do not think one had much need of it—the splendid air was as good as any amount of beer—still, there it was for those who wanted it and could pay for it. And now, having approached the end of my description of the commissariat, perhaps it will be as well to give your readers an idea of the ordinary month's mess bill, as it is rendered every month to probationers and clerks, and premising, by the way, that in addition to the cost of the above food and beer there would be added his wash bill, and an account for any tobacco and cigars he might have ordered should he be a smoker. Now, if I remember rightly, my mess bills on the average came to about £3 15s. to £4 per month, and this included beer, tobacco, and an extra now and then for breakfast; indeed, I think mine ought to be looked upon as rather an extravagant amount than otherwise. These bills are made out by a messman chosen by the staff, who caters for them. Should anyone have complaints or suggestions to make he has an opportunity of doing so at meetings held once a month (I think) for this purpose, when domestic affairs are discussed, and at which the superintendent is present to listen to complaints or suggestions.

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I can remember some very interesting little discussions, which I think went a long way to maintain harmony and to prevent grumbling in our little colony, the superintendent being always ready to listen to our wants, and as far as in him lay to carry out our wishes unless they might be quite against rules. In this way there was no bottling of discontent.

I am afraid, Sir, I have spun out this account of my experience as a probationer somewhat too much, but I am anxious to do my little best to remove any suspicion that may arise in the mind of intending applicants for probationership at P.K., first as to the alleged monotony of a telegraph clerk's life; next as to the accommodation afforded being either not good, or but so-so; and thirdly, as to the manner in which the company looks after and cares for its *employés* being anything but what it should be.

To the first objection I would say that I sincerely believe it is a clerk's own fault if he find the life monotonous, or degenerate into a machine; and from the little experience I have had I do not believe there is the least necessity for its being so.

Next I would say that the accommodation at P.K. was as good as could possibly be expected; nay, more, it was excellent.

And with regard to the third point, in addition to what I have already said as regards library, piano and billiards, let me say that the clerks are obliged to attend service at least once on a Sunday, and that the choir at the church close by is almost exclusively composed of them, one of the clerks, in my time at least, generally playing the harmonium. And yet farther, with reference to something of a diametrically opposite nature to the above, let me say that any endeavour to get up theatricals was willingly countenanced by the superintendent. Whilst I was there we had some Christy minstrels, which were by no means bad, and which, I think, must have enlivened the most wearisome, if any such there were. On that occasion we experienced no opposition from the superintendent, but rather the contrary, who, if I am not very much mistaken, is the same gentleman who signs himself "W. H. A.," and whose kindness I had the pleasure of experiencing during my stay at P.K.

Now, Sir, I have done what in me lies to give a description of a probationer's life in the Eastern Company. I could say much more, but hope that enough has been said to thoroughly endorse Mr. A.'s letter, and to show that one at least recalls none but most pleasant memories of his treatment at the hands of the Eastern Company and their able superintendent at P.K., when he signs himself

QUONDAM PROBATIONER.

NEW PATENTS, 1880.

350. ELECTRIC LAMPS.—*Messrs. Puydt and Conquet, Brussels.*
351. TELEPHONES.—(*A communication.*)—*L. Davis, Birmingham.*
404. TELEPHONIC COMMUNICATION.—*G. Westinghouse.*
409. TELEGRAPHY AND TELEPHONY.—(*A communication.*)—*W. R. Sake.*
455. ELECTRIC LAMP.—*T. H. Blamins, Huddersfield.*
471. TELEPHONIC APPARATUS.—(*A communication.*)—*H. Lake, London.*
478. ELECTRIC MACHINES.—(*A communication.*)—*T. Morgan, London.*
553. ELECTRIC LIGHT.—*C. W. Wigner, London.*

ABSTRACT OF PATENTS.

2110. PRODUCING LIGHT BY ELECTRICITY, *C. W. Siemens.—Dated 27th May*, 1879. 10*d*.

This relates to a means of effecting the feed of the terminal of an electric lamp, by causing it to bear against a point or edge near its heated extremity, so that it can advance as it wastes.

2340. ELECTRODES FOR ELECTRIC LIGHT, *A. M. Clark.—Dated 12th June*, 1879.—(*A communication.*)—(*Not proceeded with.*) 2*d*.

This consists in a rod of metal placed in the centre of a cylinder of carbon of a highly conducting kind.

TRAFFIC RECEIPTS FOR FEBRUARY, 1880.

COMPANIES.	Feb. 1880.	Feb. 1879.	Incrse.	Decrse.
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	3,200 estd.	2,775	425	—
Direct Spanish Telegraph Company	—	—	—	—
Direct United States Telegraph Company	—	—	—	—
Eastern Telegraph Company	44,591	37,251	7,340	—
Eastern Extension Telegraph Company	25,190	22,409	2,781	—
Great Northern Telegraph Company	14,160	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—

TELEGRAPH SHARE LIST.

COMPANIES.	CLOSING PRICES MARCH 10.		BUSINESS DONE WEEK ENDING MARCH 10. Highest.	Lowest.
Anglo-American Ordinary	59¾,	60¾	60	59¾
Do. "B"	88¼,	¾	89	88
Do. "A"	32,	½	32½	31⅛
Brazilian	7¾,	⅞	7 15-16	7¾
Cuba	8⅞,	9⅛	9	9
Do. Ten per Cent. Pref.	16,	⅝	16⅝	16¼
Direct Spanish	2,	⅛	—	—
Do. Ten per Cent. Preference	10¾,	11¼	11⅜	10¾
Direct United States	11⅛,	⅜	11½	11⅛
Eastern	8 15-16,	9 1-16	9 1-16	8 15-16
Do. Six per Cent. Debenture	103,	6	104½	103
Do. Five per Cent. do.	101,	3	102¼	101⅛
Do. Six per Cent. Preference	12,	¼	12⅛	12⅛
Eastern Extension	8⅞,	9	9 1-16	8⅞
Do. Six per Cent. Deb.	105,	8	—	—
German Union	8½,	9	8⅞	8⅜
Globe Telegraph and Trust	5 9-16,	11-16	5⅝	5½
Do. Six per Cent. Preference	11 5-16,	7-16	11½	11¼
Great Northern	9⅜,	⅝	9 9-16	9⅜
Indo-European	24,	6	24⅝	24⅜
Mediterranean Extension	3,	⅛	—	—
Do. Eight per Cent. Preference	10¾,	11¼	—	—
Reuter's	10,	11	—	—
Submarine	232,	7	236	234¾
West India and Panama	1⅜,	⅞	1⅞	1 11-16
Do. Six per Cent. Preference	7¾,	8	7⅞	7⅞
Western and Brazilian	7⅛,	⅜	7⅜	7⅛
West. Union Seven per Ct. 1st Mt.	120,	5	—	—
Do. Six per Ct. Sterg.	102,	4	105	105

ADDRESSES.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

PETER BROTHERHOOD, Engineer, 56 and 53, COMPTON-STREET, GOSWELL-ROAD, E.C.
Specialities—Patent 3-Cylinder Engines (Silver Medal, Paris), as used by Siemens, Gramme, and Wilde for driving Electric Machines.

RANSOMES, SIMS, and HEAD, Orwell Works, IPSWICH.
Specialities—Portable and Stationary Engines, fitted with patent governors, as tried in the electric lighting experiments on the Thames Embankment.

ABBOTT and Co., NEWARK-ON-TRENT.
Specialities—The "Standard Size" Vertical Cross Tube Boilers. Illustrated catalogue, giving every detail of a variety of Boilers 2s. 6d., post free.

CARBON ELECTRODES COMPANY. Works: 39, COMMERCIAL-ROAD, EAST.
Specialities—Carbon Rods of all sizes for Electric Lighting. Also, Plates and all other Moulded Carbon Goods. List of prices on application.

M. THEILER & SONS, Telegraph Instrument Manufacturers, 86, CANONBURY-ROAD, N. Works: ALWYNE-LANE, N.
Specialities—Morses, Polarised Relays, Saunders' Curb Keys, Type Printers, Recording Sounders, Duplex Apparatus (Theiler's Patent).

HOOPER'S TELEGRAPH and INDIA RUBBER WORKS, MITCHAM and MILLWALL DOCKS.
Contractors for the Manufacture and Laying of Submarine Telegraph and Torpedo Cables. Manufacturers of Hooper's celebrated Insulated Core. Printed reports on application. Offices: 31, LOMBARD STREET, LONDON, E.C.

THE BRITISH ELECTRIC LIGHT COMPANY (Limited), 41, PARLIAMENT-STREET, WESTMINSTER, and 17, WATER-STREET, LIVERPOOL.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

ESTABLISHED 1851.

BIRKBECK BANK.—Current Accounts opened according to the usual practice of other Bankers, and Interest allowed on the minimum monthly balances. No commission charged for keeping Accounts.
The Bank also receives money on Deposit at Three and a Half per Cent. Interest, repayable on demand.
The Bank undertakes for its Customers, free of charge, the custody of Deeds, Writings, and other Securities and Valuables; the collection of Bills of Exchange, Dividends, and Coupons; and the purchase and sale of Stocks and Shares.
Letters of Credit and Circular Notes issued for all parts of Europe and elsewhere.
A Pamphlet, with full particulars, on application.
FRANCIS RAVENSCROFT, Manager.
Southampton-buildings, Chancery-lane.

The Birkbeck Building Society's Annual Receipts exceed Four Millions.

HOW TO PURCHASE A HOUSE FOR TWO GUINEAS PER MONTH, with immediate Possession and no Rent to pay. Apply at the Office of the BIRKBECK BUILDING SOCIETY.

HOW TO PURCHASE A PLOT OF LAND FOR FIVE SHILLINGS PER MONTH, with immediate possession, either for Building or Gardening purposes. Apply at the Office of the BIRKBECK FREEHOLD LAND SOCIETY.
A Pamphlet, with full particulars, on application.
FRANCIS RAVENSCROFT, Manager.
Southampton-buildings, Chancery-lane.

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SLIP

BENGAL.—Mr. J. K. Spence has been appointed Postmaster-General of Bengal, in place of the late Mr. T. W. Gribble.

DIRECT SPANISH TELEGRAPH COMPANY.—Direct cable communication with Spain, *viâ* Bilbao, is now fully restored.

THE ELECTRIC RAILWAY.—Siemens' Electric Railway is, we believe, to be installed at the Crystal Palace during the present summer.

ROYAL EXCHANGE.—The electric light is being fixed in the Royal Exchange basement, which is now being fitted up as a coffee tavern.

THE ALBERT HALL.—The management has decided to reintroduce the Siemens' light, with the improvements recently made by Dr. Siemens.

ELECTRO-OPTICS.—Dr. J. Kerr continues his description of the experiments he has made in this direction in the current number of the *Philosophical Magazine*.

CENTRAL ASIA.—A *Times* telegram states that the construction of the telegraph line between Tchikislar and Chatti is progressing at the rate of about five versts per day.

THE CALABRIA.—This ss., belonging to the Telegraph Construction and Maintenance Company, with the Hong Kong-Manilla cable on board, arrived at Port Said, on March 15.

QUADRUPLEX.—Dr. Alexander Muirhead has successfully established the Muirhead and Winter quadruplex system on the land-line from Torbay, Nova Scotia, to New York of the Direct United States Cable route.

SYDENHAM.—On Tuesday evening a large audience assembled in the Lecture Hall, Sydenham, to hear a lecture by Mr. A. B. Harding, on the electric light. A new lamp, the invention of Mr. Hickley, was used, two of which beautifully lighted up the Hall.

EXPORTS.—The value of telegraph wire and apparatus exported during the two months of 1880 to the end of February, is given as £86,115 as against £65,404 during the similar period in 1879. Of this the value of the exports in February amounted to £54,302, as against £24,685 in February, 1879.

THE ELECTRIC LIGHT has at last been adopted in the Crystal Palace, and certain chilly mortals have, of course, found it to appear disagreeably cold. "They miss the warm, comfortable appearance of gas." On the whole, however, the effect was a great improvement, and the eye will soon get accustomed to the change of tint.

ANGLO-FRENCH TELEGRAPHIC CONVENTION.—The international rate from April 1 is 25c., or 2½d., per word. Each country retains its own receipts, including those for prepaid answers, except that England gives to France 11c. and France to England 14c. per word. France also charges and retains 12c. per word extra for telegrams to or from Algeria and Tunis.

PROGRESS IN AMERICA.—In order to render the contents of *The Electrician* as complete a history as possible of electrical progress, we have arranged to insert periodically special articles on progress in America. These articles will be written by gentlemen in America, whose position gives them exceptional facilities for gaining early and authentic information.

OXIDATION OF GOLD BY GALVANIC ACTION.—Grotthus, says Mr. Berthelot, observed that a gold wire is dissolved when employed as the positive terminal of a circuit in sulphuric acid. The author confirms these results, and shows that under similar circumstances nitric acid also dissolves gold. This is due neither to ozone nor, as suggested by Chevreul, to persulphuric acid, for neither of them has any action on gold.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—The accounts to the 31st December last show, subject to audit, a balance of £106,825 after payment of three interim quarterly dividends. Out of this sum the board propose to pay on the 22nd April a final dividend of 2s. 6d. per share, or at the rate of 5 per cent. per annum for the year 1879, and to carry the balance of £81,856 to the reserve fund.

A "NEW" ELECTRO-MAGNET.—M. Chambria increases the surfaces presented to each other on the core-end and armature of an electro-magnet by forming a projection on the latter, which enters a hollow of the core, or, conversely, a projection on the core is made to enter a hollow in the armature. By this means he increases the portative force of the magnet on the armature nearly 100 per cent. The residual magnetism, too, is weakened by this device.

REPRINTING "THE ELECTRICIAN."—A contemporary seems to imagine that reprinting a large portion of *The Electrician* without acknowledging the source is no very grave matter. There is, however, we may inform him, a well understood literary law which strongly condemns the morality of such a proceeding. It may lessen the cost of production in the case of our contemporary to extract our City reports, and reprint our notes, but it does not say much for his honesty when he allows the obligation to pass without acknowledgment.

THE "ECONOMIST" ON TELEGRAPHS.—In reviewing the commercial history of 1879, our contemporary says:—"Telegraph securities have been steadier throughout '79 than any other class of investment. The traffics have shown an important increase on all the lines, and, in the case of the Atlantic lines, counteracted to a great extent the effect of competition by a French company started during the finance mania in Paris, and the first of whose cables is expected to be opened shortly. The Eastern system has benefited by the establishment of the cables to the Cape *viâ* Aden, which was contracted for by the Telegraph Construction Company in March.

THE BATTLE OF THE TELEPHONE COMPANIES.—The Edison Telephone Company, fortified by the disclaimer to Edison's telephone patents, have stopped the Indiarubber, Gutta Percha, and Telegraph Works Company (Limited) from making the Blake transmitter for the Telephone Company (Bell's). The Edison Company holds that transmitter to be an infringement of their patents, and they are determined to take steps against any other company making these transmitters. There is no especial merit in the Blake transmitter that its disuse should seriously inconvenience the Bell Company, since Crossley's or any other good microphone will answer just as well.

RESISTANCE OF TOUGHENED GLASS.—M. Ducretet finds that toughened glass opposes a much greater resistance to passage of electricity than ordinary glass, and he has employed it in the construction of Leyden jars, which may be more highly charged than the common sort. M. Becquerel points out that this fact may be of some electrical value as leading to the construction of extremely thin condensers, giving great effects. Perhaps the glass will be found suitable to take the place of mica sheets in the construction of fine

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condensers. We remember years ago suggesting to Sir Wm. Thomson that he should use Leyden jars of this toughened glass for his quadrant electrometers.

Deposition of Silver.—The *Bulletin* of the Geological Society of France describes an ammonite of silver, found in a silver mine at Caracoles, South America, by M. Fremier, who was for some time director of the mines at that place. This remarkable specimen was found with a number of other ammonites belonging to the two species, *A. peramatus* and *A. plicatilis*, which had not been mineralised with silver salts. The ammonite in question, however, had been entirely replaced by chloride of silver, which had been partially reduced to the metallic condition. Light is thrown by this specimen upon the origin of the native silver which occurs in the Caracole mines; for it is only fair to infer that this metal has, in like manner, been reduced from the state of chloride.

The Holborn Viaduct.—Lieut.-Colonel Heywood, in his report for 1879, says:—"In regard to the electric lighting of the Holborn Viaduct, which was terminated on the 9th of March last year, the report says that the 16 lamps employed in a length of 473 yards—an area of 14,200 superficial yards—of roadway was £5 per night, or 6s. 3d. per lamp. No photometrical observations of the light were made; but, from figures given in the report to the Metropolitan Board of Works upon the electric light on the Thames Embankment, it might be reckoned that the lamps on the Viaduct gave, when unenclosed, about five times the light of ordinary gas lamps, and when enclosed in opal globes (as they were when in use), twice as much only, and that the actual cost was nearly four times that of gas."

Sulphur Baths.—Messrs. Clermont and Trommel contribute an article on this subject to the *Bull. Soc. Chim.*, of which the *Jourl. Chem. Soc.* gives the following abstract:—"Becquerel has stated that the electromotive force of polysulphides to monosulphides is in the proportion of 163 to 248. As the therapeutic action of sulphur baths has been ascribed to their electromotive force, some physicians have prescribed baths of sodium monosulphide instead of polysulphide. The authors have shown that the amount of sulphuretted hydrogen evolved from the bath of monosulphide bears to that evolved by polysulphide the inverse proportion to their electromotive forces. By adding manganese chloride to a solution of monosulphide of sodium at 34°C., 0·0118 gram of sulphuretted hydrogen was liberated, whilst from a solution of polysulphide of similar strength 0·0206 gram escaped. As the polysulphide is less efficacious from the medical point of view than the monosulphide, it is evident that the quantity of sulphuretted hydrogen liberated is not, at least in the case cited, proportional to its therapeutic action and to the strength of the electric current."

"Out of the Frying Pan into the Fire."—The following remarkable piece of criticism is found in the review of Mr. Anderson's work on "Lightning Conductors" in one of our weekly contemporaries:—"We are so well satisfied with Mr. Anderson's work that we must point out two statements which the author should modify in the next edition, for the book has a fair claim to standard value. One of them is a slip which is surprising in an electrician, unless we take it as a result of that extreme narrowness of groove into which there is an increasing disposition for the study of the specialist to glide. It is the definition (p. 59) of the unit of electricity, called the ohm, as the 'amount which would be generated by a gramme weight falling through the distance of one metre in one second.' The words 'in one second' have no business there. A gramme, or any other weight, takes its own time to fall, and does so at the rate of 4·9 metres in a second. One volt, which is the unit of electromotive force, as the ohm is the unit of electrical resistance, absorbs 44·24 foot pounds per second, and is produced by the consumption of 1-3000th gramme of zinc in a Daniell's cell." The author of the book criticised and the critic himself have much to learn as to the system of absolute units devised by the Committee of the British Association.

Telegraph Rules and Tariff.—A series of revised rules and tariff, relating to the transmission of telegraph messages in India and between India and Ceylon, have been sanctioned by the Governor-General in Council, and will come into operation on April 1. No alteration is made in the charge for transmission of messages, namely, one rupee for every six words or groups of three figures, exclusive of the address between any two stations in India, and one rupee and eight annas for the same number of words between any station in India and any station in Ceylon. The following public functionaries have the power to "clear the line," that is, to suspend the receipt and despatch of all messages until the one for which the line is "cleared" is passed on:—The Governor-General; the Governors of Madras, Bombay, and Ceylon; Commanders-in-Chief, India, Madras, and Bombay; Lieut.-Governors of Bengal, North-Western Provinces, and the Punjab; Secretaries to the Government of India; Secretaries to the Governments of Madras, Bombay, Bengal, North-Western Provinces, and the Punjab; Chief Commissioners of Oude, the Central Provinces, British Burmah, Mysore and Coorg, and Assam; Agents to the Governor-General, Rajpootana, and Central India; Commissioners of Sind and Peshawur; the Resident at Hyderabad (Deccan); Director-General of Telegraphs in India; the Maharajah of Patiala, from the Patiala office only. The messages so sent have, however, to be paid for in cash or in stamps as other State messages.

Stimuli in Sensitive Nerves.—In experiments on the rate of propagation of stimuli in sensitive nerves it has been generally assumed that, under like conditions of experiment, and with an equal length of nerve path from the point of stimulation to the centre, the reaction time is always the same. This, tested recently by Messrs. Hall and Kries (Du Bois-Reymond's *Archiv*, 1879, Supplement, p. 1), is found, says *Nature*, to be not confirmed. Stimulating with a slight induction shock the finger point and the middle of the outer side of the upper arm, the reaction in the latter case occurred with Mr. Hall later than that from the finger (on an average about 0·005 second). In Herr von Kries, the reaction time was shorter (about 0·003 sec.) from the upper arm than from the finger. Again, the reaction time was measured when light was made to strike different parts of the retina and even here (the lengths of nerve-path being equal) presented considerable differences. In Mr. Hall's case the difference between the outer and inner part of the retina was 0·018 sec., that between the upper and lower 0·023 sec.; in Herr von Kries's the differences were respectively 0·061 and 0·064 sec. In comparison with the place of direct vision still greater differences appeared. Experiments were also made in stimulating the forehead and the tongue, in which cases the paths were assumed to be nearly equal. In both observers the reaction-time from the tongue was somewhat longer than from the forehead, though, according to Weber, the sense of space at the tip of the tongue is about twenty times finer than on the forehead. The authors conclude that the reduced reaction times differ considerably according to the place of stimulation, that in the eye the differences are connected with differences of functional power, that the reaction method is not available for ascertaining the velocity

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of conduction in sensitive and motor nerves, and therefore the velocity in the spinal cord is still unknown.

A "Novel" Source of Frictional Electricity not Novel.—"I wish to put on record," says Professor W. F. Barrett in a letter to *Nature* for March 4th, "the fact which I communicated to the Physical Society last week, that the motion of a chalk cylinder under a metallic surface generates an electric current having an E.M.F. of rather over 1-3rd of a volt. The chalk used had been impregnated some months before with a solution of phosphate of soda, but when used was practically dry, and had a hard, smooth surface, almost like polished marble. The strength of current depends on the rate of rotation, and the pressure on the surface of the chalk; the latter simply diminishes the internal resistance, which is, of course, very high. The discovery is due to a suggestion made to me so long ago as last November, by Professor Sylvanus Thompson, who wished me to try whether the motograph receiver of the Edison telephone could be used as a transmitter. I was unsuccessful at the time; but, under favourable circumstances, I find the voice is faintly but accurately transmitted on speaking into the receiver, so long as the chalk is made to rotate." Professor Barrett's communication is, of course, very interesting to an electrician, especially the last part, where he announces the use of Edison's electro-chemical receiver as a transmitter; but he need not, perhaps, have been in so great a hurry to put it on record as a novelty, for it is nothing more than Edison's well-known "chalk cylinder battery," which has been published in this country for the last six months and more. Edison found that the chalk cylinder and platinum rubber which he employed in his telephone act as a battery or generator of electricity, giving an electomotive force equal to half that of a Daniell cell, which is just about what Professor Barrett makes it. Four cylinders in series equal two Daniell cells. The resistance is only 50 ohms when the battery goes, but 1,200 when at rest. Professor Barrett is a zealous disciple of Mr. Edison, and an eloquent preacher of his merits. How comes it that he was so ignorant of his master's achievements? and how is it that even he has incurred the charge of "stealing the Edisonian thunder?" However it be, he has our sympathy, for he will now understand what it is to offend the (Yankee) gods.

Telegrams Addressed to Places Abroad.—The Postmaster General has issued a notice stating that under the St. Petersburg Convention, as revised in London, the following alterations in the regulations respecting foreign telegrams will come into force on the 1st April, 1880:—1. The principle of a word tariff, instead of a fixed charge for a minimum number of words, will be extended to European telegrams, and the charges will be the same from the country as from London. 2. The compulsory collation (repetition) of cypher telegrams will be abolished. 3. Proper names will no longer be allowed in the text of code telegrams, unless used in their natural sense. 4. In European code telegrams any of the languages in use in the different countries of Europe, or Latin, will be allowed; but no telegram will be allowed to contain words drawn from more than one language. In extra-European code-telegrams, only the following eight languages will be allowed, viz., English, French, German, Italian, Spanish, Portuguese, Dutch, and Latin; but words drawn from any or all of these languages will be allowed in one and the same telegram. 5. The charges paid by the addressee for the repetition of an inaccurately transmitted telegram will be refunded. 6. Numbers written in words will be counted according to the manner in which they are written by the sender. For example, "Two hundred and thirty-four" would be counted as five words; but "Twohundredandthirtyfour" as two words in European telegrams (fifteen letters to a word), and three words in extra-European telegrams (ten letters to a word). 7. In extra-European telegrams groups of figures or letters will be counted at the rate of three (instead of five) to a word. 8. The length of the reply to a telegram which can be prepaid by the sender will be limited to thirty words, and a form will be handed to the addressee enabling him to send a reply at any time within six weeks. Should the addressee not use the form, the amount paid for the reply will be returned to the sender, provided that the addressee returns the form within six weeks to the Post Office, accompanied by a request that the money may be refunded to the sender. In no case will the amount be paid to the addressee. 9. The charge for each copy (after the first) of a telegram containing a multiple address will be reduced from 5d. per copy of twenty words to 5d. per copy of one hundred words.

City of London Union and the Telephone.—Mr. Freeman, in pursuance of notice at the late meeting, moved "That it be referred to the General Purposes Committee to consider and report as to the desirability of connecting the office at 61, Bartholomew-close, with the several houses by the use of the telephone, and what will be the cost of such connection." The telephone, he said, was one of the most wonderful and curious inventions of the day, not only enabling persons to put themselves in communication with one another at a distance, but enabling them to carry on a conversation at a distance. One of the greatest evils they had to contend with in the Union was that they had three or four establishments in various places in the metropolis at a distance from each other. Matters very often arose at the board which, if they could only deal with at once, there would be no necessity to refer to committees, for committees to consider and report upon, or debates to take place upon. To obviate this difficulty the master or the steward of the various establishments attended those offices from two o'clock in the afternoon until the board adjourned, and frequently time was saved by referring to them. But if they had the telephonic connections which he suggested, and wanted to know what the doctor had to say upon any particular case, or to hear an explanation from the chaplain or other officer, it would be merely necessary for the clerk to have a few moments' conversation with the gentleman in question and return with full particulars. In many respects the telephone appeared preferable to the existing telegraph, which cost £140 per annum for maintenance. Mr. Douglas seconded the motion. He said that he should not like to see the present communication in any way removed until there was satisfactory security on the part of the telephone company for the due performance of their duties. Mr. Boor remarked that for some time the Streets Committee of the Commissioners of Sewers had had under consideration two applications from telephone companies for the establishment of their system of communications over the City of London. That body had declined to give their permission at present, in consideration of the fact that the subject of distribution of news, &c., by these companies, was now under consideration in the Law Courts. He admitted that the telephone was a most wonderful invention; but he did not think that it had arrived at a sufficiently matured stage to justify a public body in adopting it. A show of hands was then taken, which resulted in 11 voting for, and 14 against the motion. Mr. Freeman then claimed a division, which resulted as follows:—For the motion, 14; against it, 22. The board adjourned.

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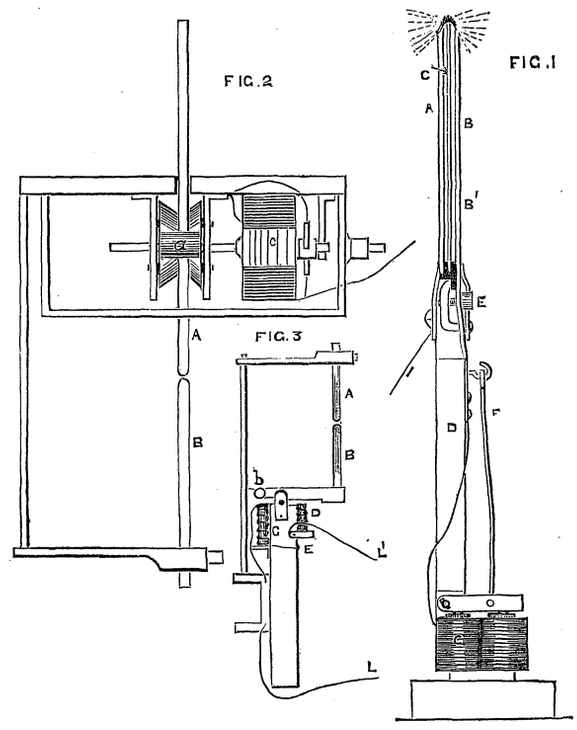
ANDREWS' LAMP AND MACHINE.

At the last meeting of the Society of Telegraph Engineers a lamp was described, the invention of a gentleman whose name failed to reach our ears. The following, however, is we believe a full description of the lamp in question, together with other inventions by Mr. Andrews.

THE MACHINE.—This gentleman constructs a dynamo electric machine in the following manner:—On the surface of a long cylinder a number of electro-magnets are fixed parallel to the axis, each magnet consisting of a long iron core wound lengthwise with insulated wire. This cylinder, constituting a rotating armature, is mounted in bearings, and made to revolve between the poles of two stationary electro-magnets which extend radially on each side of the armature, the outer ends of these magnets being connected by iron with each other, so that the two form a complete horse shoe. The wires of the armature coils are connected to a suitable commutator, which is in connection with the coils of the stationary electro-magnets, so that the electrical currents generated in the armature coils excite the stationary magnets, whereby more powerful currents are generated. The arrangement of the machine is such that the parts are largely exposed to the air, and are kept cool by the air currents caused by the rotation of the armature. The means adopted for approximately proportioning the quantity of electricity produced to the number of lamps which have to be supplied from the machine is to wind the coils of the machine with several separate parallel wires, connecting each wire through its commutator to a contact plate or spring. These plates or springs bear against the face of a sliding bar or a revolving disc or cylinder, part of which is of conducting and part of non-conducting material, so that by sliding the bar or turning the disc or cylinder more or less round, a greater or less number of the contact plates or springs are brought to bear on the conducting portion which is in connection with the lamp circuit, and thus the quantity of electricity passing into the circuit can be increased or diminished. The contact plates or springs may be arranged so that the movement of the bar, disc, or cylinder causes a greater or less number of them to be connected in series. According to another method, when the coils of the machine do not consist of separate parallel wires, he introduces into the external circuit a solenoid having an iron core, which is connected to a throttle or other regulating valve of the engine that works the machine in such a manner that, according as the strength of the electrical current passing through the solenoid is greater or less, the core is caused to move more or less by its attraction, and so by moving the valve to regulate the speed of the engine and machine. Instead of applying this apparatus directly to the regulating valve of the engine it may be applied to vary the outlet of a fluid pumped by the engine to act on a piston connected to the regulating valve.

THE LAMP.—According to one arrangement two plates of carbon, preferably in the form of discs, are placed face to face, a little distance apart. These plates being connected to the electric circuit, the luminous voltaic arc presents itself at some point to their peripheries, and as the carbons are gradually consumed the arc travels round the periphery and inwards towards the centre. In order to ensure the travel of the arc round the periphery of the discs, he winds the conducting wire in a number of convolutions near the discs, thus inducing rotation of the arc. These convolutions may be round a core forming an electro-magnet or solenoid. Or a permanent magnet may be employed to induce rotation of the arc. For the purpose of kindling the lamp he makes one of the carbons movable, and connects it to the armature of an electro-magnet, or to the core of a solenoid having its coil in the lamp circuit, and this may be the coil that causes rotation of the voltaic arc. When there is no electrical current passing the carbons are in contact, but as soon as the electrical current passes through the coil, the carbons are separated by the attractive force of the electro-magnet or solenoid, and are maintained at a distance apart suited to the development of the voltaic arc. For one of the carbon discs a metal vessel kept cool by water may be substituted, as in the water terminal of the Siemens lamp. The lamp described at the meeting above-mentioned consists of a rectangular carbon plate for the negative terminal, placed between two other plates at a small distance from them, these outer plates constituting the positive terminal. Each of the outer plates being conected at one of its side edges to the circuit, the voltaic arc travels along the upper edge between it and the negative carbon until it reaches the farther side, whereupon it travels back between the other outer plate and the negative carbon, and so on continuously. The two outer carbons may be connected at their side edges so as to form a flat tube containing the negative carbon, in which case the travel of the arc to and fro along the upper edge of the tube is induced by a few convolutions of the circuit wire in the neighbourhood of the carbons. When alternating currents are employed the middle carbon plate is insulated, the two outer plates in that case forming part of the lamp circuit. The voltaic arc plays between the two outer plates, being always kept at their extreme edges by the presence between them of the middle plate which becomes consumed along with them. When carbon plates producing the voltaic arc between their edges are used, the travel of the arc along such edges is caused by connecting the plates to the circuit at points which may be made to vary in position by introducing into the circuit an electro-magnet having an armature which, by vibrations, makes and breaks contact, these vibrations being damped in any known manner. According to a modified arrangement of lamp, two plates or rods of carbon are kept pressed together end to end, and to and near the point of junction is directed the point or end of another carbon rod or plate. The two rods or plates first mentioned constitute at their meeting point the positive terminal of the lamp, and the third rod or plate is the negative terminal. As the former are consumed at their meeting point, they are still pressed together, keeping that point stationary, and the third rod or plate has its distance from that point regulated by an electro-magnet or solenoid. Another arrangement employs a single carbon rod for the positive terminal, and a single carbon



for the negative terminal; and these are mounted in slides so that the weight of one of them, or an additional weight if required, causes them to approach point to point. In the lamp circuit a small electro dynamic machine is put, the rotating axis of which is connected by gearing to the carbon slides, so that when it revolves, it moves the slides in the direction opposite to that in which they are moved by the acting weight. As this weight causes the carbons to approach each other whilst the electro-dynamic machine causes them to recede from each other, the force of the latter depending on the strength of the current, their distance becomes automatically adjusted, so that the forces in the two directions are balanced, or nearly so. As the carbons consume, increasing their distance, and so weakening the current, the force causing their approach is in excess. If the carbons approach too near to each other, the force causing recession becomes the greater, and they are separated. Instead of employing an electro-dynamic machine for adjusting the distance of the carbons, two electro-magnets, or solenoids, may be used, the coil of one of which is connected by a shunt with the lamp circuit. This coil, acting in opposition to the weight of the movable carbon, or to a weight tending to separate the carbons, causes the carbons to approach each other; but when they do approach sufficiently to permit passage of electricity, this electricity excites the other coil, and the armature or core attracted by it shuts the former coil out of circuit, again leaving the weight free to act, so as to separate the carbons.

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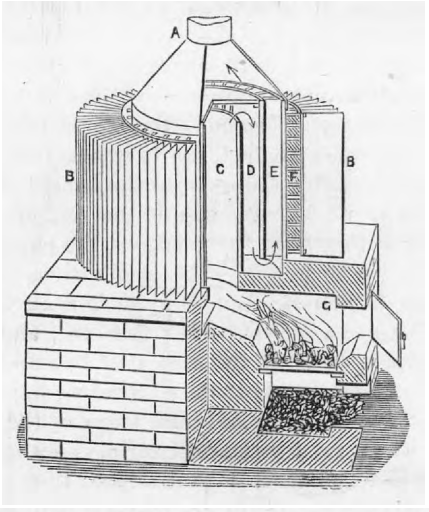
THE NEW THERMO-ELECTRIC BATTERY OF M. CLAMOND.

In referring to the patents of M. Sudre (who is understood to be working in conjunction with M. Clamond), we have already* noticed some of the features embodied in the new thermo-pile of M. Clamond. This, as shown by our illustration, is constructed in the form of a stove, by means of which the apparatus for heating and lighting a building may be combined.

The elements of the battery (exhibited at F) are constituted by prisms of an alloy of antimony and bismuth, connected by strips or "armatures" of sheet iron; "chains" of 50 elements being produced at one casting. The iron strips connect the right-hand face of one prism with the left-hand face of the next in order, so that one set of alternate junctions becomes heated, whilst the other set becomes cooled by the "diffuser" (B). The middle portion of the strip is of about the same size as the side of the prism, and the strips are cut with three projections or teeth, which are twisted corkscrew-fashion, so as to obtain a good hold of the metal. A series of these "armatures" being arranged in a special mould, with their twisted projections bent at right angles, and the middle portions surrounded with asbestos cardboard, the alloy is run into the mould, filling the spaces between these protected middle portions, and the chain is complete. In the battery of 3,000 couples there are 60 chains of 50 couples each, and these chains may be connected either in series or in "multiple arc." The face of the prism is about 3 cm. square, and the thickness is 2 cm.



The chains are insulated from the heating and cooling surfaces (at E and B) by means of very thin sheets of mica, which, it is stated, impede the heat conduction only in slight degree. The mean temperature of the heated faces of the prisms is about 360° C.; that of the opposite faces being not more than 80°.

According to the experiments of M. Cabanellas, referred to in *La Nature*, the electromotive force of a battery of 3,000 elements, in single series, is 109 volts (equal to about 60 Bunsen cells); whilst the internal resistance is 15·5 ohms.

In regard to fuel consumption, the largest battery hitherto constructed, composed of 6,000 couples, consumed from 9 to 10 kilograms (20 to 22lb.) of coke per hour, whilst working two Serrin lamps, the light from each of which varied from 30 to 50 Carcel *becs*. If this expenditure represented the lighting power only, the apparatus would certainly be defective from an economical point of view; but this is not the case when the thermo-pile can be utilised also as a stove for heating purposes. Nearly the whole of the heat produced by the combustion of the fuel is, in fact, available for such purposes. The measure of practical success that may attend the persevering and praiseworthy endeavours of M. Clamond is, we think, mainly dependent upon the question of the durability of the thermo-pile, which resolves itself into that of the effect upon it of a high temperature continuously maintained, and, what is more formidable, the effect of successive heating and cooling. The combination of the most effective and unobjectionable means of heating and lighting buildings is one of the most important and beautiful problems of practical science; and we shall be glad if M. Clamond, who has done so much in this direction, should succeed in practically establishing a claim to its full solution.

* *The Electrician*, Vol. iii., p. 32.

ON THE DYNAMO-ELECTRIC CURRENT AND ON CERTAIN MEANS TO IMPROVE ITS STEADINESS.*

BY C. WILLIAM SIEMENS, D.C.L., F.R.S.

The author, after alluding to the early conception by Dr. Werner Siemens of the dynamo-electric or accumulative principle of generating currents, makes reference to the two papers on the subject presented, the one by Sir Charles Wheatstone and the other by himself, to the Royal Society in February, 1867. The machine then designed by him, and shown in operation on that occasion, is again brought forward with a view of indicating the progress that has since taken place in the construction of dynamo-electric machines, particularly those by Gramme and Siemens-von Alteneck. The paper next points out certain drawbacks to the use of these machines, both of them being subject to the disadvantage that an increase of external resistance causes a falling off of the current; and that, on the other hand, the short circuiting of the outer resistance, through contact between the carbon electrodes of an electric lamp, very much increases the electric excitement of the machine and the power necessary to maintain its motion, giving rise to rapid heating and destructive sparks in the machine itself.

An observation in Sir Charles Wheatstone's paper is referred to, pointing to the fact that a powerful current is set up in the shunt circuit of a dynamo-electric machine, which circumstance has since been taken advantage of to some extent by Mr. Ladd and Mr. Brush, in constructing current generators.

The principal object of the paper is to establish the conditions under which dynamo-electric machines worked on the shunt principle can be made to give maximum results. A series of tables and diagrams are given, the results of experiments conducted by Mr. Lauckert, electrician, employed at the author's works, which lead up to the conclusion that, in constructing such machines on the shunt principle, the resistance on the rotating helix has to be considerably reduced by increasing the thickness of the wire employed, and that on the magnets has to be increased more than tenfold, not by the employment of thin wire, but by augmenting the length and weight of coil wire employed.

The results of this mode of distributing the resistances is summarised as follows:—

1. That the electromotive force, instead of diminishing with increased resistance, increases at first rapidly, and then more slowly towards an asymptote.

2. That the current in the outer circuit is actually greater for a unit and a half resistance than for one unit.

3. With an external resistance of one unit, which is about equivalent to an electric arc, when thirty or forty webers are passing through it, 2·44 horse-power is expended, of which 1·29 horse-power is usefully employed, proving an efficiency of 53 per cent., as compared with 45 per cent. in the case of the ordinary dynamo-machine.

4. That the maximum energy which can be demanded from the engine is 2·6 horse-power, so that but a small margin of power is needed to suffice for the greatest possible requirement.

5. That the maximum energy which can be injuriously transferred into heat in the machine itself is 1·3 horse-power, so that there is no fear here of destroying the insulation of the helix by excessive heating.

6. That the maximum current is approximately that which would be habitually used, and which the commutator and collecting brushes are quite capable of transmitting.

Hence the author concludes that the new machine will give a steadier light than the old one with greater average economy of power, that it will be less liable to derangement, and may be driven without variation of speed by a smaller engine; also that the new machine is free from all objection when used for the purpose of electro-deposition.

This construction of machine enables the author to effect an important simplification of the regulator to work electric lamps, enabling him to dispense with all wheel and clockwork in the arrangement. The two carbons being pushed onward by gravity or spring power are checked laterally by a pointed metallic abutment, situated at such a distance from the arc itself that the heat is only just sufficient to cause the gradual wasting away of the carbon in contact with atmospheric air. The carbon holders are connected to the iron core of a solenoid coil, of a resistance equal to about 50 times that of the arc, the ends of which coil are connected to the two electrodes respectively. The weight of the core (which may be varied) determines the force of current that has to pass through the regulating coil in order to keep the weight in suspension, and this in its turn is dependent upon the resistance of the arc. The result is that the length of the arc is regulated automatically, so as to maintain a uniform resistance signifying a uniform development of light.

* Abstract of a Paper presented to the Royal Society.

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STUDY.

"Crafty men contemn studies, simple men admire them, and *wise men use them;* for they teach not their own use : but that is a wisdom without them and above them, won by observation." We have taken the liberty of italicising Bacon's remarks concerning wise men and studies, as it seems that our younger readers need reminding again and again of the convictions to which the most thoughtful men of every age have given allegiance.

In our issue of February 21 we noticed that arrangements had been made, by permission of the Lords of the Committee of Council on Education, to give a series of courses of lectures on the application of physics to the Arts. Among the courses announced was one by Professor W. G. Adams, F.R.S., on "Electrical Measurement." This series of lectures was to have commenced on the 5th of March. The lectures, however, were conditional, and it is because the conditions have not been fulfilled that we draw attention to the matter. Thirty applications from students desirous of joining the classes were required to be made at a stated time previous to the day named as that on which the lectures were to commence. We have heard on the best authority that the number of applications was far short of the thirty required, and hence the lectures have not been delivered. When we consider that thirty names only were required, and that the number of people in London interested in telegraphy and other branches of applied electricity, or engaged in preparing pupils for the South Kensington, the City Guilds, or other examinations, must necessarily be reckoned by thousands, we cannot conceive a reason why the opportunity was not eagerly seized, not by tens but by hundreds. It is hardly too much to say that ninety-five per cent. of the men and women at present pretending to prepare pupils for examination in electric and magnetic subjects know absolutely nothing of the application upon which Professor Adams was to lecture. If the masters are too indolent or too self-satisfied with their own crass ignorance, it is hardly to be expected that the pupils will show much earnestness to obtain information lying outside of that pitiable object, a cram text-book. Possibly we are altogether wrong, and any of these masters would undertake to prove us wrong in the course of five minutes. They would argue that their object was to train and expand the mind, to direct the evolving powers of their young charges, so that in the future there might be less narrow-mindedness, and more ability to think correctly and come to right conclusions. Our utilitarianism is in their eyes the despicable carping of those who do not rightly understand the work of the Educator. We have not the time, nor is this the place, to answer such criticisms fully. They generally arise, however, from the intense ignorance of the critic. He does not see that men are born into the world to fill a certain position—to do work in fact, work which the better it is done conduces so much the more to the benefit of humanity. We think that no science should be taught as a mere abstraction, but that from the very first the pupil should be led to see as far as possible the applications to which his knowledge might be put. But, suppose for an instant that the schoolmaster could make out a fair case, and compel us to except those preparing for scholastic examinations from the number of those to whom the lectures we have mentioned would prove beneficial. What have many of the postal-telegraph *employés* to say for their dilatoriness—what those who desire posts in telephone companies—and those, again, who are looking to the progress of the electric light to give them work and wages? Are those employed in electro-metallurgical operations, or who desire to be employed in such operations, satisfied with their knowledge in this direction? The result leads us to suppose so.

Is it not the lot of every one of us who happens to be placed in a position of command to hear to the full the constant declamation of dissatisfaction of the majority of those around. After a considerable experience, we are bound to say that the lot of every man is ordinarily the result of his own work. Except in certain cases of patronage, the best man generally obtains credit and position. The best man is frequently the one who does not possess that which the world calls genius, but is of fair average ability and makes his work, whatever it may be, his constant "study." It may be he obtains employment as a sender and receiver of telegraphic messages. He tries to perform his duties in the best possible manner, but at the same time he neglects no opportunity of making himself conversant with the duties of the post next above him, and should the occasion arise, as surely it does in the life of every one, when he is called to act, he is ready. This class of men is not numerous. The majority are content to undertake work, to do it with the least expenditure of labour to themselves, are utterly unable to act in an emergency, and are constantly

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grumbling at their position. We do not pity such, who have exactly what they deserve. We know of a quite recent case in point. An influential company introduced some new apparatus. The inventor put everything in working order and left. The whole worked admirably for a time, and the clerks were delighted; but after a while, as happens sometimes with apparatus, there came a hitch. Any clerk of average ability could, with a week's perseverance, have mastered the theory of the apparatus, but no one had thought it worth while. The company had it put up, the company must find some way to remedy any mischance. The clerks reasoned that they were paid to do certain work, and they did it; and it was unlikely that they should trouble themselves further about any matter. The inventor had to travel over six thousand miles to put the apparatus right, and a clerk was sent to learn how to act in the case of another mishap. This clerk is, of course, put over the heads of those previously working in the office, and justly so. The men may grumble, but who is to blame?

Often has the plea been put forward that for those willing to learn there was no place within reach where information could be obtained. The plea goes for what it is worth, and that is very little. The excuse of hundreds in telegraph and other offices in relation to the lectures above mentioned is that they have no bearing upon their particular work. What has the ability to make electrical measurements to do with a Morse sender. It is not his place to test this or to test that, and, therefore, it would be a waste of time to trouble about the subject. We contend that no time is wasted in studying any part of the theory, of which the application, in some shape or other, is in your hands. The first essential move towards success is "Study," the intermediate step is "Study," and that upon which your final success depends is "Study."

THE ELECTRIC LIGHT AND ITS PARENTS.

On the two or three occasions last year when the Electric Light was exhibited and discoursed upon in the presence of the general public we gave our readers a descriptive account of what took place, and of the impressions carried away by the several audiences. The shortcomings of the light itself, as well as the weakness of its advocates, when these were open to criticism, were freely and impartially commented upon, and we have since had no reason to regret our candour. When, therefore, a purely professional audience took the subject in hand, as it did at a meeting of the Society of Telegraph Engineers a few evenings ago, we felt that we owed it to our readers not to shrink from a similar line of action in respect to it. In the interests of the public we are the more constrained to outspoken criticism because although the Telegraph Engineers would probably disclaim exclusive responsibility for the Electric Light, their action and verdict upon it will be regarded by the unprofessional world as authoritative. There is in fact no other body of experts so competent to pronounce upon its merits, and none whose decision the public would receive with as much respect.

It is to be regretted, therefore, that a meeting summoned by the broad and attractive announcement that "Recent improvements in Electric Lighting" were to be discussed was narrowed to the consideration of a few and for the most part well-known methods. The paper read by Mr. Alexander Siemens was a full and lucid description of some modifications recently introduced into the machines made by Messrs. Siemens Bros; and it was supplemented by explanation of the adjusting action of certain new lamps also made, or adopted, by Messrs. Siemens Bros. These and a lamp of Mr. Crompton's invention comprised the working exhibits for the evening—the only other lamp lit up being one that would, the inventor hoped, be in a suitable state of forwardness for a fair trial in a few months' time. The Hall was lighted by a large Siemens' lamp; but as this special distinction has been conferred upon it at several previous public gatherings there was no novelty in that. Indeed, while on this subject, we may observe that we wish we could report any novelty concerning it. It no longer drops splinters of burning carbon on to the heads of the audience; but in all other respects it behaved much as it did at the Society of Arts—that is to say its illumination was capriciously uncertain and its sibilations undeniably certain.

Of course there were the usual arithmetical calculations, prepared with greatest care and fullest detail showing indisputably that the Electric Light is—or was, under certain conditions—from fifty to sixty per cent. cheaper than gas. Somehow, however, these figures were not convincing; and the only consolation one felt in listening to them was that they were submitted to an audience whose duty it would be to test them impartially. It is only fair to the author of the paper to state that he frankly admitted the calculations were applicable only to great lights; and he discountenanced the notion that for general distributive illumination Electric Lighting could as yet economically compete with gas. Unhappily, however, the figures reach the public, but the disclaimer does not; and we trust that this important part of the subject will receive the further attention it deserves before the discussion, which has been adjourned, is closed. The fallacy in most cases lies in comparing the respective cost of equal lights instead of the actual costs of adequate lights. In that way a Siemens lamp could be proved to be cheaper than our Editorial candle. The public also may fairly demur to a fixed standard of candle-power for any Electric Light that varies, as many of them do, to the extent of thirty to fifty per cent. below their maximum intensity. The true test, for example, of relative necessary cost in the case of the Hall in which this discussion took place would be Messrs. Siemens' expenditure for the evening, as against the registering of the Institute of Civil Engineers' gas meter for the previous evening.

We make these reflections not, our readers may be sure, in depreciation of the Electric Light, present or to come; but in order that calculations may be based upon ascertained facts not upon sanguine expectations; and we feel sure that the truest interests of the Society will be served, as matters stand at present, in disabusing the public mind rather than in encouraging over-hopeful speculations. Strange to say, no reference at all was made to "recent improvements" in America. Reticence on this point is unpardonable. Either there is something worth mentioning in that quarter, or else there is, as some people suspect, nothing but what is dictated by fraud and reported by ignorance. The English public have a claim on the Society of Telegraph Engineers to be set right on this point.

Speaking of the American inventions reminds us that in the course of the discussion Mr. André was asked to describe a new form of lamp—or rather globe, perfected by Mr. Brougham, and which to all appearance solves in the simplest manner possible the problem upon the solution of which by Mr. Edison a mint of money has been staked in the United States. In a globe that is water tight, and surrounded by water contained in an outer globe, the carbons burn and speedily consume all the oxygen. This is done so effectually that with the expenditure of an inch or so of carbon a condition of things is brought about within the globe which enables the remainder of the carbon to burn for, it is said, one hundred and twenty hours. The light we are assured is admirable as well as enduring; and we hope that at the next meeting it will have a place among the exhibits.

Turning now to the discussion which followed the reading of Mr. Alexander Siemens' paper we have to note an incident which the non-resident members of the Society may wish they had been present to witness. Mr. Crompton's lamp was on view, and although its exhibition was not in the programme it had its turn in a most unexpected manner. Commenting upon the mechanism of Siemens' lamps Mr. Crompton naturally claimed some superiority for his own; but at the same time suggested in a very generous spirit that the great firm were not doing themselves justice in the light they were exhibiting; as, although he was not an electrician, he had learnt sufficient by experience with his own lamp to satisfy him that the fluctuations in the light which illuminated the Hall were due, not as Mr. Siemens had suggested to the new and untried engine attached to their machine, but to the insufficient external resistance in the circuit. At this Mr. Siemens jumped up and began manipulating the wires "just to see *the steadiness* of *your* lamp,"—under the same conditions. Englishmen always feel flattered, as well as astonished, at the mastery of our language which many foreigners display in a degree which very few of us can pretend to over continental languages; but although the English language is not essentially a language of politeness it has many amenities which are seldom forgotten by gentlemen; and a general feeling spread about the room that a challenge under such conditions, if made at all, should have been couched in very different terms. However, the challenge was promptly accepted, everybody in the interval of darkness which ensued between the turning out of the Siemens' lamp and the turning on of the Crompton's, predicting failure for the Englishman. But triumph, for once, did not reward the most confident.

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Mr. Crompton's lamp, thus suddenly called upon, burnt with perfect steadiness, composure and silence—and with a brilliancy certainly equal to if not exceeding that of the Siemens'.

This unlooked for result forced Mr. Siemens on his feet again—in spite of the suggestion of the President that all further discussion should be postponed—to explain that what he had meant to say was that the engine was latterly running faster than the mechanism of Siemens' lamp had at first been adjusted for. How this explanation mended matters we are at a loss to see, considering the fact that the speed was an unknown quantity to Mr. Crompton when his lamp was incontinently put in circuit.

This, and the description of another lamp, which, however ingenious, does not appear to have been practically tested, covered the whole of the proceedings for the first night's discussion of "Recent improvements in Electric Lighting." The one-sidedness of the whole business was, perhaps, inseparable from the conditions under which it was initiated; but we hope that the adjourned discussion will travel into regions altogether new, or else confess that really nothing new deserving attention has been devised since the lectures and exhibitions of last year. In the hope of eliciting the actual truth in regard to this question so seriously affecting the material interests of the general public, as well as those of scientific investigators, we have thought it right to pen these lines.

SOLID NICKEL BRONZE *VERSUS* NICKEL PLATING.

In our notice of the Mining Exhibits at the Applied Science Exhibition, Paris, we proposed to devote a separate article to the operations of the Société Française Anonyme de Nickel, 38, Chaussée d'Antin, Paris, owing to the richness and purity of the Garnierite deposits in New Caledonia, and the improved methods of treatment devised by their discoverer, M. Jules Garnier, which are bringing about a revolution in this branch of metallurgy, and, indeed, in the whole nickel trade. Whereas, formerly, France was dependent upon other countries, including Germany, Austria, and Sweden, for her supplies of nickel ore, she is now enabled to supply the metal itself to those very countries, and at so moderate a price as to warrant the belief that before very long solid nickel bronze will completely supersede nickelised brass and copper in most branches of manufacturing industry. Not only is the thin coating of nickel deposited by galvanic action liable to peel off, but also the wear due to cleaning, as well as ordinary use, soon exposes the yellow metal beneath. On the other hand, articles made of the new white nickel bronze are the same all through their substance, and with a mere ordinary cleaning present that pure tint and dull lustre which renders this metal so pleasing to the eye.

Discovery and Nature of the Ore.—In 1863 M. Jules Garnier was entrusted by the Minister of Marine and the Colonies to explore the mineral wealth of New Caledonia, the French penal settlement, and was soon attracted by a beautiful green mineral enclosed in the magnesian rocks which form the backbone of the island. He sent specimens to the Rev. W. B. Clark, Geologist to the Government of New South Wales; Professor Liversidge, of Sydney University; and Professor Dana, the American geologist, who unanimously gave the name of garnierite to the new mineral in honour of its discoverer. Garnierite differs from pimelite, with which it is sometimes compared, in being a hydrosilicate of nickel and magnesia, whereas the latter is merely an oxide of nickel or silicate of oxide of nickel, generally contained in an aluminous gangue. The vein-stone of garnierite is slightly translucent, and appears to be a sandy argillaceous magnesia contained in magnesite, or meerschaum. M. Garnier is of opinion that garnierite is contemporaneous with the magnesian rocks, having been deposited while in solution in hot silicious water in the numerous clefts, of greater or less extent, which divide the serpentines. It is here that the ore occurs in the greatest purity and abundance, though it is also met with in the diallage rocks, the diorites, and the amphibolites. It is presented in the form of a coating, of nodules, or of threads, as well as in actual veins, either in fragments or dust, owing to the brittle character of the mineral. The nickel is associated with iron, chrome, and cobalt, but neither sulphur, arsenic, nor antimony are present. The following is an analysis of an average or typical specimen of garnierite:—

		Oxygen.
Silica	41	22
Protoxide of nickel	19	4·07
Magnesia	16·4	6·56
Alumina	0·6	0·28
Lime	trace	—
Water	20	18
Gangue	3	—
Total	100	

Professor Dana assigns it the formula—

$$(Mg\,O.\,Ni\,O)^{10}\,[SiO^2]^8 \times 3\,H\,O;$$

but M. Garnier, after many analyses, considers it should be represented by—

$$(Mg\,O.\,Ni\,O)\,Si\,O^2 \times n\,H\,O.$$

The principal point in New Caledonia at which the ore is worked is Kanala, on the north-east coast towards the middle of the island, where its contents in oxide of nickel varies from nothing to about 40 per cent. It is also met with in the serpentine formations, commencing in the south, where they occupy the whole breadth of the island, whence they continue along the eastern coast to Monéo, and in the west to the northern extremity, where they include the islands of Néba, Yandé, and Bélep.

Treatment of the Ore.—The fragments of minerals may be divided into five categories:—Pure and tolerably compact ore; ore serving as a coating for the nodules or conglomerates, composed of the debris of serpentine rocks; ore simply colouring magnesian clays more or less ferruginous; ore filling the clefts of a millstone grit associated with the serpentines; and ore in thin flakes alternating with flakes of pure silica. As the rocks forming the ore are intimately associated, and are of very nearly the same density as oxide of nickel, there can be very little mechanical separation of the pure ore from its gangue. All that can be done is to effect a preliminary riddling, so as to separate the large from the small pieces. The small are, according to circumstances, ground or conglomerated before being charged into the reducing furnaces, while the large are classified according to their percentage of nickel, the product to be obtained, and the system of treatment to be followed. Some of the fragments are sufficiently large and compact to be dealt with in their natural state, but the rest are previously ground and conglomerated.

M. Jules Garnier, who takes an active part in the company's affairs, has devised and patented two separate systems of reducing the metal from the ore. The first consists in simply melting the ore in a special furnace with sulphurous substances, such as iron pyrites or sulphide of calcium, in which case the object is to reduce all the oxide of nickel, and as little as possible of the oxide of iron. In this way a sulphide of nickel and iron is obtained, similar to the matte of the old process, but containing more iron and less sulphur. At any rate, it may be of such composition that it can be pulverised, and then easily dissolved in acid, when the ordinary dry method is followed. This system is chiefly employed for the manufacture of sulphates of nickel for electro-metallurgy.

The second method consists of two separate processes:—1. The ore is subjected to a reducing fusion in a blast furnace of such a height and shape that not only is all the oxide of nickel reduced, but also the metallic nickel is sufficiently carburised to become deposited and to remain liquid in the crucible of the furnace. Naturally, the greater portion of the iron contained in the ore accompanies the nickel, and a carburated regulus is obtained, consisting of nickel and iron, which is tenacious and tolerably malleable.—2. This regulus is melted on the hearth of a reverberatory furnace, and subjected to oxidising action. The carbon and the silicon pass off first, and afterwards the chromium, manganese, and iron, which assumes the state of oxides, and then of scoria, in the order of their affinity for oxygen. The nickel which remains is either run into pigs, or, if in a ball, is cut up for the market.

It is this second method which is chiefly employed for producing nickel commercially pure. The first process is conducted at Nouméa, the capital of New Caledonia, in furnaces erected by Messrs. John Higginson and Co., the concessionaires of the ore, who have also contracted to supply the Société Française Anonyme de Nickel with as much regulus as they may require. As this substance contains so large a proportion of metal as 70 to 80 per cent. a great saving is effected in the freight. The second process is carried on at works put up by the company at Septèmes, near Marseilles, placed under the management of M. Thiollier.

Products.—The most important products of the company are ingots and granules containing 99½ per cent. of pure nickel, which is guaranteed, and ¼ per cent. of utilisable metallic substances, the remaining ¼ per cent. being waste. These are for mixing with other metals in forming various alloys, such as the white nickel bronze, containing on an average 20 per cent. of nickel. Though the company do not themselves produce these alloys they undertake to inspect the casting of the ingots at the works of the most skilful French founders, and to guarantee their quality. They also supply anodes, or plates, of nickel absolutely pure, for restoring to the galvanic bath the metal taken up by electro-deposit, as well as salts for forming the bath, though they are endeavouring as much as possible to supersede

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this use of the metal by the solid nickel bronze. These salts are the double sulphate of nickel and ammonia—

$$So^3\ NiO,\ So^3\ Az\ H^3 + 7\ H\ O,$$

for nickelising cold, and the simple sulphate of nickel—

$$So^3\ Ni\ O + 7\ H\ O,$$

which serves for hot nickel-plating—a quicker process than the former, but giving less satisfactory results.

MANUFACTURED ARTICLES.—M. Jules Garnier observes that nickel is one of the most impressionable metals which exist, and that infinitesimal doses of certain substances are sufficient to change its qualities. He has devoted much attention to the formation of various alloys containing from 17 to 30 per cent. of pure nickel, and also copper, zinc, and tin, the melting of which does not take more than from 5 to 10 minutes—no longer, in fact, than ordinary brass or gun-metal. These alloys are easily worked and soldered, leave no smell after being handled, and become whitened if plunged into acid on leaving the mould; they vary in tint, according to the mixture employed, from silver white to a greenish or blueish white and the much-prized hue of oxidised silver. Nickel bronze—the alloy most generally used—has various percentages of nickel, according to the purpose for which it is to be employed, but to be white and unoxidisable it should contain at least 20 per cent. of pure metal.

At the Applied Science Exhibition the company brought together manufactured articles connected with every branch of industry, contributed by upwards of forty sub-exhibitors, with the object of demonstrating that all articles made of brass or copper nickel-plated may also be produced in solid nickel bronze, which is the same all through its substance. All operations, whether casting, rolling, drawing, beating out, turning, chasing, or engraving, are performed with the same plant and by the same processes as in the case of brass or copper, and at practically the same cost, while the finished articles are 20 per cent. stronger. Among these may be especially noticed the castings of Messrs. Lehmann Frères and Messrs. Gaspard and Belle, the cocks and taps of Messrs. Sécutowicz and Huber, the quincaillerie of M. Gits and Messrs. Rivain and Besant, the locksmith work of Messrs. Vaillant, Fontaine, and Quintart, one of the earliest firms to employ nickel bronze. There were, besides, the vessel fittings of M. Quinier, the grease cups of M. Mancort, the carriage work of M. Horstmann, the stable fittings of M. Laloyand, and the harness mountings of the Maison Million, and the white German silver table services of M. Lange, very different from the yellow alloy that has hitherto been known as German silver. Nor is the use of nickel bronze confined to purely industrial purposes; it is equally capable of finer applications, as evidenced by the stamped and engraved work of Messrs. P. Echart and Co. and M. Foucault; while for surgical instruments, as exhibited by M. Demeure, it is eminently suited on account of its non-oxidibility. In arts it is capable of wide application. Bronze statuettes were shown by M. Pinedo and M. Norman; and mirror frames by M. Carpentier. M. Girandon has succeeded in producing a highly pleasing effect in his art furniture by covering it with the skin of the China shark, inlaid with nickel bronze. Finally, the goldsmith's art applied to nickel bronze was represented by M. Chertier and Messrs. Gruhier and Tranchard.

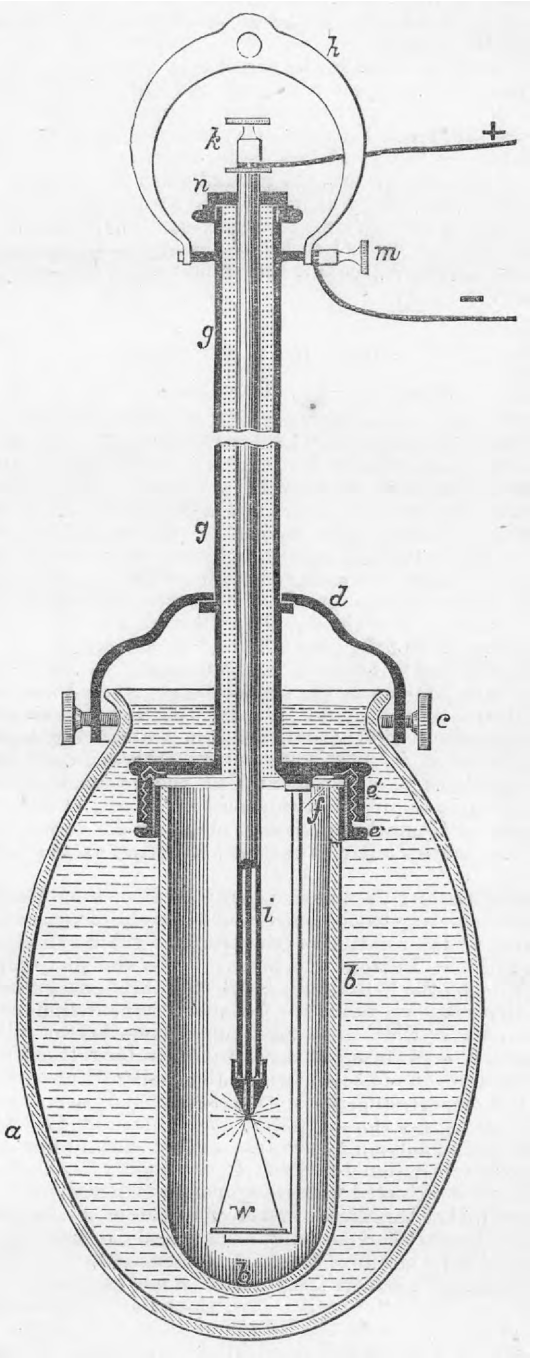
M. Laroque has found that a small percentage of nickel added to steel increases its strength, and that tools made of this alloy stand better than those of steel, while they are not liable to oxidation. Tramway wheels, rolls, parts of machines, anvils, hammers, hatchets and other edge tools, and also a torpedo needle made of acier Laroque, attracted a considerable amount of attention at the Exhibition. M. Crouzet-Hildebrand showed a fine-toned bell of nickel bell metal, and it is said that he intends henceforward to employ this alloy exclusively.

In conclusion, it may be stated that, thanks to the almost inexhaustible deposits of ore in New Caledonia, and the methods of reduction which have been much simplified by M. Garnier, pure nickel can now be sold at about half the price demanded three years ago. A gold medal was awarded by the jurors of the Paris Exhibition of 1878, two diplomas of honour at the Applied Science Exhibition, Paris, 1879—one for raw materials, the other for finished products—and the same prize at the Marseilles Industrial Exhibition of last year. Those of our readers who are interested in nickel and its applications will be glad to know that the English agents are Messrs. Charles Watson and Co., 29, Great St. Helens, London.—*Mining Journal.*

THE BROUGHAM-ANDRE LAMP.

In our account of the exhibition of the André lamp at Stafford House, given in our last issue, we mentioned that the Hon. R. T. D. Brougham had recently made some improvements, which bid fair to make this lamp the best of its kind. The illustration given below will enable our readers to understand the construction of the lamp, and the improvements of Mr. Brougham.

THE LAMP.—This consists of two concentric tubes, *g g*, *i i*, separated by insulating material. The interior tube, *i i*, contains the carbon rod, 2 mm. in diameter, which falls by its own weight on to the wedge-shaped mass of copper, *w*, connected to the outer tube, *g g*, by the conductor, *f*, the outside cylinder is connected to the negative pole of the battery, the interior to the positive. The cap, *n*, is of vulcanite. A small weight is placed above the carbon rod to assist its descent. The glass globe, *b b*, is furnished at its open end with a brass cylinder, *e*, which is slightly bevelled, while the cap *e'* has a corresponding groove. Between the two is placed an india rubber washer, *f*, so that by screwing up *e* into the cap *e'*, the washer is forced into the recess and a good water-tight joint is made. The globe *b b* may be called the lamp globe, to distinguish it from *a a*, which is another glass globe, of any required shape, containing water or some liquid non-absorbent of light rays.



MR. BROUGHAM'S IMPROVEMENT.—The steadiness of the incandescent light over that of the arc has long been understood, but hitherto the cost of the one has been so great that practically it was out of the question for general use. This will account for the little progress made by the Werdermann light. The cost is due principally to the consumption of carbon. Again, it is well known that the consumption of carbon, in an atmosphere

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containing no oxygen, or in a vacuum, is reduced to a minimum. Many inventors have tried to make lamps to retain a perfect vacuum, but have failed. It is easy, however, to make a water-tight joint, and by surrounding this with water Mr. Brougham has solved one of the problems of the incandescent lamp. The oxygen originally in the lamp globe is quickly exhausted, and then the atmosphere consists of gases which do not combine with carbon, and the result is very slow combustion or disintegration. The water-tight joints having been obtained in the manner above indicated, the globe *a a* is partially filled with water, so that when placed over the lamp globe, the water is well over the cap *e'*. This water globe is fastened by means of clamps and screws as shown in the drawing. The inventor states that while the carbon burns away at the rate of six inches per hour in the open air, it burns only one-eighth of an inch per hour when in the water-covered globe. This shows an enormous saving in the cost of carbon, and if it can be shown that the saving thus obtained is greater than the cost of the extra power absorbed by the incandescent lamp over that of the arc, a decided step will have been made towards furnishing a light that can without difficulty be applied to ordinary sized rooms. We have seen this lamp and can testify as to its steady light.

So long as the liquid in the vessel *a* is above the cap *e'* of the lamp, no atmospheric air can enter the lamp globe, and at the same time the heat from the lamp is carried off or dispersed and the light diffused. Provision may be made for the removal and replenishing of the liquid in *a*, or for causing it to circulate, but we are of the opinion that the ground glass globe, as shown, will prove more satisfactory as it is than any addition to the apparatus can make it. We made inquiries as to the liability of the copper wedge to melt, but its size and its connection with so large and such good conductors removes all tendency in this direction.

PHYSICAL SOCIETY.

March 14.—Dr. HUGGINS in the chair.

Mr. W. CHANDLER ROBERTS, F.R.S, drew attention to an explanation which had recently been suggested by Dr. Van Riemsdijk, of Utrecht, to account for the "flashing" which attends the solidification of cupelled buttons of gold and silver. He showed experimentally that at the point of solidification the metals emit a flash of greenish light, which Dr. Riemsdijk points out is probably due to the fact that globules are really in what is known as the superfused or surfused state—that is, they fall some degrees below their point of solidification without setting, and that the change from the liquid to the solid state is accompanied by the liberation of the latent heat of fusion, which again heats the globule and renders it incandescent. In an attempt to obtain indications as to the state of certain fused metals by the aid of the induction balance, Mr. Roberts was able to show that the resistance of silver in the molten state is far greater than when the metal is solid, and, on the other hand, he had confirmed De la Rive's statement that the resistance of molten bismuth is less than that of the solid metal, and he also obtained evidence that bismuth, in cooling, may be made to pass through a surfused state similar to that which occurs in the buttons of gold.

The SECRETARY then read a paper by Professor W. F. BARRETT, announcing that he had found a current of electricity to be generated by the rotation of the prepared chalk cylinder in the receiver of the Edison telephone. When the platinum stylus, which rubs on the cylinder, is connected through a galvanometer to the brass axle on which the cylinder is mounted, a current is observed whose EMF is over 1-3 volt. This current falls off as the rotation continues, owing, Professor Barrett surmises, to the electrification of the surface of the chalk. Professor Barrett attributes the current to friction solely, and seeks to account for the receiving action of Edison's telephone by this frictional current being modified by the transmitted currents, and not by the electrolytic action to which it is usually ascribed. These experiments originated with a suggestion of Professor Sylvanus Thompson, that the Edison receiver might act as a transmitter. Professor Barrett had at length succeeded in making it act in this capacity by means of the frictional current.

Mr. SHELFORD BIDWELL exhibited some experiments bearing on Professor Barrett's observations, which tended to show that the source of the current in the Edison receiver was due to the fact that a voltaic element is formed by the platinum rubbing point on the brass axle and the prepared chalk. This chalk is usually impregnated with phosphate of soda, or, as in the author's experiments, with caustic potash and acetate of mercury. The cylinder seems to be dry, but is probably moist. Wetting it greatly increases the current. There is a very feeble current when no motion of the cylinder takes place, but rotation of the cylinder greatly increases it. Platinum is electro-negative to brass, and hence the positive current flows from the platinum to the brass through the galvanometer. This was demonstrated by substituting zinc for platinum, when the current was reversed and flowed from the brass to the zinc, owing to the fact that brass is electro-negative to zinc.

Mr. BIDWELL showed by means of a simple pile of copper and tinfoil, separated by a moist cloth or paper, that the motion of the tin across the paper increased the current of the cell. In the case of a cell made of *two* tin plates separated by a moist paper current was set up by moving one plate over the other. The plate which moved relatively to the paper was always electro-negative to the other. Mr. Bidwell also showed by a simple experiment that the action of Edison's receiver was electrolytic. He caused the mere passage of a current to lessen the friction of a metal strap on a drum covered with moist paper, and thereby release the drum by the evolution of hydrogen.

Professor AYRTON pointed out that the rubbing action in these experiments assisted the current by bringing up fresh electrolytic matter, a fact which had been taken advantage of in the construction of several batteries.

Professor ADAMS remarked that this explanation did not seem to explain how the current was *reversed* in the cell composed of *two* tinfoil plates.

Professor GUTHRIE then demonstrated by experiment a curious anomaly in frictional electricity. When flannel is rubbed with ebonite the flannel is + electrified. When ebonite is rubbed with glass the ebonite is + electrified, and we should, therefore, expect that when flannel is rubbed with glass the flannel would be still more + electrified; but, instead of that, it is really feebly negative. Perhaps the fact that the heat of friction entering into one substance more than the other affected such results.

The SECRETARY then read a note from Mr. Ridoute, stating that he had succeeded in Dr. Guthrie's funnel experiment mentioned at last meeting, and by means of a stream of water flowing out of a glass funnel had attracted a glass cone towards the mouth of the funnel. The angle of the cone was greater than the angle of the funnel.

TECHNICAL PHYSICS.*

No. II.

We have spoken now of the battery, and of the bell, let us consider the wire, or rather wires which connect them together. We have seen that the smallest break in the wire stops the bell from ringing, but more than that, the bell does not ring so well if the wire is long as if it is short, or so well if the wire is thin as if it is thick. The battery tends to send a current, and the wires connecting the bell with the battery tend to impede or diminish the current. This we can see experimentally by using the current detector we employed before. I connect the two ends of this galvanic cell with the two ends of the wire forming the detector, and the magnetic needle swings round to about 80 deg. Stretched zig-zag on this wooden board I have a long piece of thin wire passing round a number of screws at the two ends. By joining one of the wires from the galvanic cell direct to one end of the detector, and by touching the other wire coming from the cell to one of the screws and the other wire coming from the detector to some other one of the screws, we can interpose in the circuit various lengths of this thin wire. Putting in circuit the shortest length, the deflection is, you see, reduced from 80 deg. to about 65 deg.; doubling the length of this thin wire the needle now points only to about 38 deg., and if I interpose all the thin wire which is stretched on the board, the deflection is almost nought.† Now, on the other side of the board, I have stretched similar lengths of a much thicker wire, and you see that while a length of the thin wire reduced the original deflection from 80 deg. to 65 deg., an equal length of the thick only diminishes it from 80 deg. to about 77 deg.; in fact, putting in circuit all this thick wire hardly produces more effect on the current than one length of the thin wire. All this is expressed by saying that the electric resistance of a long wire is greater than that of a short one of the same thickness, and the resistance of a thin wire greater than of a thick wire of the same length. So far the resistance of a wire to the passage of an electric current is closely analogous with that of a pipe to the passage of a stream of water, for the longer and narrower the pipe the greater the obstruction or resistance to the water; but the rougher the inside of a pipe the greater the resistance to the stream. This also has its analogy in electricity, for since the electric current passes through the wire and not along its surface, as water does along the surface of a pipe, the roughness we are concerned with in the case of electricity must be a sort of internal roughness of the material of which the wire is composed, or, in other words, the electric resistance of a wire of a given length and thickness varies very much with the material of which the wire is made—for example, while this thick copper wire being put in the circuit only reduced the deflection from 80 deg. to 77 deg., an equal length of iron wire of the same thickness diminished it from 80 deg. to about 55 deg, the resistance of iron being about six times that of pure copper. There is, however, one other sort of friction we have in pipes to the flow of water which has not an exact analogy with the electric resistance of wires, and that is the friction or resistance at the point where the water enters the pipe from the cistern, and the friction at every bend of the pipe. On the other hand, there is a

* A Course of Lectures on some of the Practical Applications of Electricity and Magnetism. Delivered by Mr. Ayrton, at the Technical School, Cowper-street, of the City and Guilds of London Institute.

† For these experiments a Grove cell was used, and the galvanometer nearly short-circuited, so that the resistance in circuit in the first instance was very small indeed.

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mode of increasing the electric resistance of a wire which has no exact counterpart in the friction of a pipe, and that is by heating the wire. At the present moment the needle of this current detector, for example, points to 40 deg.; on heating, however, this coil of wire, which is in the circuit, deflection rapidly diminishes to 38 deg., 37 deg., 36 deg., &c.

We may, therefore, sum up by saying that

RESISTANCE DEPENDS

Of a cylindrical pipe for water on	*Of a cylindrical wire for electricity on*
1. The length of the pipe.	1. The length of the wire.
2. The diameter of the pipe.	2. The diameter of the wire.
3. The roughness of its inner surface.	3. The material of which it is composed.
4. The way in which the water enters the mouth of the pipe.	4. The temperature of the wire.
5. The bends in the pipe.	

And remember that both in the case of the friction of water passing through pipes as well as in the friction of electricity passing through wires the power that is lost is converted into heat.

The analogy of the liquid friction and the electric friction is carried still further. There are some substances through which a liquid can be made to pass, but only with considerable difficulty. A porous substance like wood, in which there are a number of small pipes but with an extremely small diameter, must necessarily offer a great resistance to a liquid. This wooden cup holds mercury, and not a drop passes through the wood; but if I pump out the air from inside this glass vessel, to which the wooden cup forms a cap, then the weight of the air on the top of the mercury is no longer counterbalanced by an equal upward pressure of the air inside the glass vessel, and the result is so great a downward pressure is now exerted on the mercury that it begins, as you see, actually to trickle through the wood. And with much greater pressures water can be squeezed through thin metal. Now, if in the circuit of the cell and galvanometer we have been using we insert a bit of wood, bone, or glass, or something of that kind, we see that, practically, no electric current passes. However, on using very powerful batteries and exceedingly sensitive current detectors we find that it is not right to say that *no* current passes. All we can say is that an extremely minute current passes, which is the smaller the better the insulating quality of the material and the smaller the battery power employed.

Not only do different metals have very different electric resistances, but a comparatively slight change in the chemical purity of the metal produces a marked variation in its conducting power. And it has been from a recognition of this fact, combined with the employment of proper methods of testing so as to ensure only pure, or nearly pure, copper wire being used in submarine telegraph cables, that ocean telegraphy has been able to be made commercially successful. For, the difference in price per pound between the nearly pure copper wire employed in the present day in the construction of telegraph cables is very little greater than that of the comparatively impure copper formerly employed for such purposes, whereas the number of telegraph messages that can be sent during the day is now nearly twice as great as could have been sent through a telegraph cable of the same size using the old impure wire. And, further, it can be strictly proved that it was only by paying attention to accurate measurements of the resistance of copper wire that this great gain in speed could have been effected for the same size of cable.

In my inaugural lecture I gave some examples of impediments being thrown in England in the way of improvements in the arts and manufactures. The commercial importance of testing copper wires for telegraph cables may be regarded as another very good example of the conservative feeling which arises from the absence of technical education. For, although it was unmistakably proved by Sir William Thomson that, if the telegraph companies merely refused to allow any wire to be put into their cables unless it was commercially pure an enormous gain must necessarily accrue to the receipts of the companies, still, the simple fact that the certainty of this future gain only rested on difficult scientific proof, whereas, the small extra cost of buying pure copper was a consideration that a man even without technical education could understand, caused the directors to stoutly resist Sir William Thomson in his efforts to introduce the very precaution which ultimately led to their own enrichment.

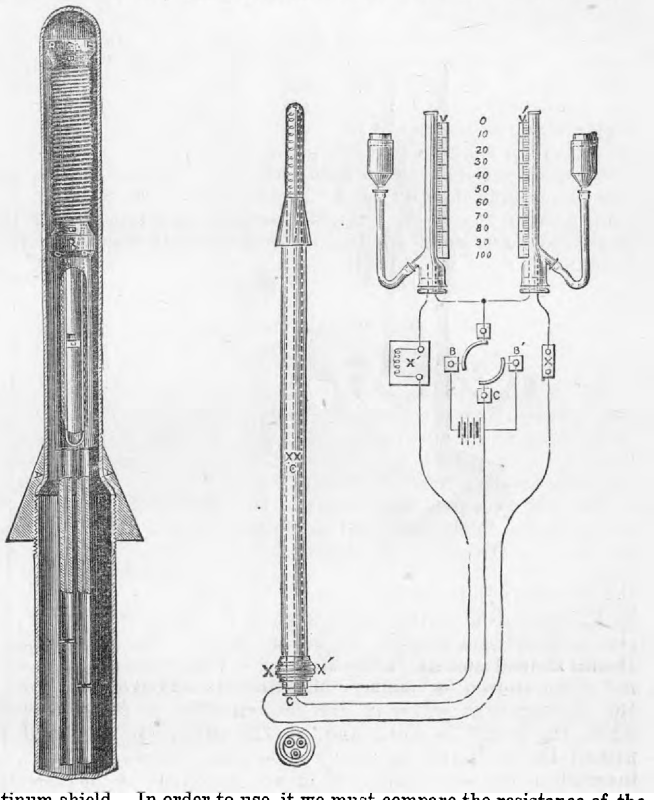
We have said that the resistance of a wire increases as the temperature is raised. If, then, we measure carefully the resistance for different temperatures, we shall for the future know either the resistance for any temperature, or the temperature corresponding with any resistance. But we can measure the resistance of a wire at a distance from it; the needle of this galvanometer, you see, moves when the assistant heats that coil of wire on the other side of the room, consequently, we can measure the temperature of a spot at a distance from it. Now, this method has been practically employed by Dr. Siemens in his electric resistance pyrometer in measuring the temperature of the sea at various points underneath its surface, a subject of great importance in connection with ocean currents, and in measuring underground temperature, a subject of no less importance.

Again, the baker of china is very anxious to know the temperature of his oven; it concerns the iron manufacturer to be able to accurately measure the temperature of the blast of hot air blown into the furnace. Now, an ordinary mercury thermometer cannot, of course, be employed for such a purpose, as the glass would melt and the mercury turn into vapour. A thermometer of iron, with air in it expanding by heat and moving an index might be employed, but the electric resistance pyrometer is more convenient, and it has the great value that the observations can be made at a distance from the furnace, say in the manager's private room.

The origin of this electric resistance pyrometer is thus described by the inventor himself:—"In 1860, when professionally engaged on behalf of Her Majesty's Government in superintending the examination of the electrical condition of the Malta and Alexandria Telegraph Cable, during its manufacture and submersion, it appeared to me that heat, as revealed by its disastrous effects, might be spontaneously generated within a large mass of cable, either when coiled up at the works or on board ship, owing to the influence of the moist hemp and iron wire composing its armature. In considering the means by which such rise of temperature within the mass might be observed, my attention was directed towards that property of metallic conductors of offering, in a rising temperature, an increasing resistance to an electrical current. Accordingly, I prepared coils of copper wire insulated with silk, whose electrical resistance having been ascertained and adjusted, were enclosed in iron tubes with the ends hermetically sealed, but allowing thick insulated leading wires to pass outwards. These protected coils were placed at various points within the mass of cable as it was coiled in the ship's hold, the insulated leading wires being taken into the testing cabin. These arrangements proved of great utility in saving this and subsequent cables from destruction; for, although the external layers of cable remained out to the depth that mercury thermometers could be inserted, the coils placed in the interior of the large mass indicated a steady rise of temperature, which had reached 98 deg. Fahr. when the official test was made. A few degrees of additional rise of temperature must have destroyed the insulation of the cable, I therefore urged that cold water should be poured over it. This was not effected without strong opposition on the part of the incredulous; but when at last the water of the Thames, which was covered at the time with floating ice, was pumped over the cable, it issued therefrom at the temperature of 78 deg. Fahr., thus proving the general correctness of the electrical indications previously observed.

"It may be here remarked that in consequence of this practical test the Government consented to the construction within the ship's hold of watertight iron tanks, and also to the cable being submerged in water during its passage from the works to its destination, precautions which have ever since been adopted in laying submarine cables."

The Siemens pyrometer before you consists of a fine platinum wire, 0·01 inch in diameter, coiled upon a cylinder of hard baked pipe clay inserted in an iron tube, and protected inside from hot gases, &c., by a



platinum shield. In order to use it we must compare the resistance of the coil at some known standard temperature with the resistance at the temperature of the furnace. This might be done in a variety of ways. We might, for example, observe the deflection produced on a particular galvanometer by a given battery sending a current through the platinum coil, both when it was cold and when it was hot; but it is clear that this deflection must in either case depend on three things—(1) the galvanometer, (2) the resistance of the wire, and (3) the strength of the battery, which latter may very likely alter during a long experiment, whereas the only element in the problem we desire should alter is the resistance of the wire. It would be as if we required to compare two weights with a spring balance, and we were in doubt as to whether the strength of the spring varied between the two weighings. A better method of ascertaining the alteration of resistance of the coil of wire in the pyrometer would be to begin by making a second coil of wire, having exactly the same resistance as the first when it was cold, and then simply to compare the resistances of the two when the pyrometer was heated. As you do not yet know the exact connection between the deflection of the galvanometer with the current passing through it, or indeed even of the exact connection between the strength of the current and the resistance of the circuit through which it flows, the simplest mode of ascertaining how much the resistance of the pyrometer coil had increased by heating would be to see what length of wire exactly like that of which the cold coil is formed must be added to it so as to make its resistance equal to that of the heated pyrometer coil. Now with this instrument, which is called a rheostat, we can easily do this, for it consists, as you see, of a long platinum wire wound in a spiral groove on a cylinder made of ebonite, a mixture of india rubber and sulphur, and an excellent insulator. The electric current enters the spiral at one end, but it does not flow along the whole length of the wire, since it passes out where this metallic rubber or rider touches the spiral; the rider slides on a thick brass, far along which the current returns to the battery through the galvanometer. By revolving the ebonite cylinder by means of the little handle the jockey is made to touch the spiral at different points further from or near to the point where the current enters. In this way, then, we can easily insert any length of this wire into the circuit, the numbers on the brass rod carrying the jockey indicating the number of complete revo-

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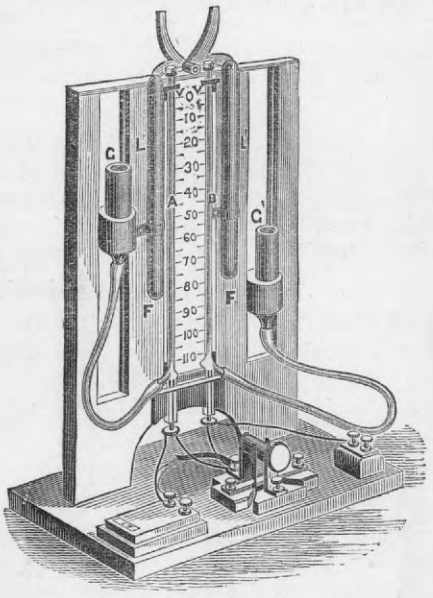
lutions made of the cylinder, and the marks on the circumference of the cylinder itself indicating by the one that we find opposite the small fixed pointer the fraction of a revolution.

Perfect, however, theoretically, as this arrangement appears to be, it has certain practical disadvantages, especially when used on board ship. First, in order to use a galvanometer such as we have been employing, it is necessary that the table should be moderately steady, and that there should not be pieces of iron moving about near it. That shaking the table causes the needle to swing about it is hardly necessary for me to show you, and you see that by moving this piece of iron near the galvanometer the needle tends to follow it. Now, a steamer rolling in the sea, with its engines working, is the very opposite of a steady table with no motion of iron near it. These disadvantages can be overcome, and have been overcome; the first by suspending the magnetic needle by a silk fibre, not simply from above, but also from below, and adjusting these suspending fibres so that no rolling of the ship causes the needle to deflect; the second, viz., the disturbances produced by the motion of the engines, by encasing the whole galvanometer in iron an inch or more thick. Dr. Siemens, however, prefers to employ a totally different method, which consists in making use of a property of the electric current we have not hitherto referred to. When a current passes through a liquid it usually decomposes it, splits it up into two components, one of these appearing where the current enters the liquid and the other where it leaves it. For example, if I pass an electric current fromone of these pieces of platinum to the other in this liquid, which consists



of a mixture of sulphuric acid, you observe gases are rising rapidly from the two pieces of platinum in this voltameter, as it is called. These gases are constituents of both the water and the acid, the particles of one or other or both of which are being torn asunder by the electric current. Having allowed some of the gases to rise into the two tubes above the pieces of platinum, and which were originally each full of the liquid, you observe I can light that one of the gases of which we have obtained the larger supply, and that it burns with a faint bluish flame, while the other does not itself catch light, but immensely accelerates the burning of this half-extinguished match put into it. Now, Faraday ascertained for us that the total quantity of gas given off in a certain time by the current produced by a given battery is inversely proportional to the resistance in circuit. Consequently, if we have two voltameters, one in circuit with the pyrometer, and the other with a comparison coil which at a given temperature has exactly the same resistance as that of the pyrometer coil, then, if we employ *any* battery to *simultaneously* produce decomposition in the two voltameters, the quantities of gases produced in the two voltameters in *any* time will be exactly equal if the resistances of the voltameters are equal, or even if they are not quite equal, provided that their resistances are very small compared with either of the two platinum wire coils. If, now, the pyrometer be heated, and the resistance of the coil inside it increases, less gas will be produced in the voltameter attached to it than in the other one in the same time, and the proportion of the two quantities of gas produced in the same time, whether that time be long or short, will give the inverse ratio of the two resistances in each of the circuits.

Perhaps I ought to mention in passing that you must never attempt to light the combined gases produced in a voltameter such as this, made of glass of ordinary thickness, seeing that the gases exist in exactly the right proportions to produce a most violent explosion on their being chemically united.

One difficulty in the use of this electric thermometer that would at once suggest itself to some of you would be that, if the pyrometer is far away from the voltameter, we must use long wires to connect the two together, and these wires would add resistance to one side without any compensating resistance being added to the other, so that we could not expect equal volumes of gas to be always given off, even when both the pyrometer and the balance coil were at the same temperature. The way, however, this difficulty is overcome is seen at once from the figure; three wires go to the pyrometer, and not merely two, and the connections are, as you see, so made that, although the leading wires to the pyrometer may be long, just as much resistance will be added to one side of the balance as is added to the other.

I have dwelt at some length on this electric resistance pyrometer, partly on account of its practical value, and partly because the use of it constitutes the first example I have given you of any exact measurements in electricity.

(TO BE CONTINUED).

TELEGRAPH SHARE LIST.

Companies.	Closing Prices March 17.		Business Done Week Ending March 17. Highest.	Lowest.
Anglo-American Ordinary	59⅜,	60	60½	59¾
Do. "B"	88⅜,	89½	90	88⅝
Do. "A"	32½,	33	33¾	32¼
Brazilian	7 11-16,	13-16	7⅞	7⅝
Cuba	8⅞,	9⅛	9¼	9
Do. Ten per Cent. Pref.	16⅛,	⅜	—	—
Direct Spanish	2,	⅛	—	—
Do. Ten per Cent. Preference	10⅜,	11¼	11¼	11
Direct United States	11,	¼	11⅜	11⅛
Eastern	9,	⅛	9 1-16	8 15-16
Do. Six per Cent. Debenture	103,	106	103⅛	103½
Do. Five per Cent. do.	100,	102	101¼	100⅛
Do. Six per Cent. Preference	12,	¼	12¼	12⅛
Eastern Extension	8⅞,	9	9	8⅞
Do. Six per Cent. Deb.	105,	108	108	107
German Union	8⅛,	9	9	8⅞
Globe Telegraph and Trust	5 9-16,	11-16	5 11-16	5½
Do. Six per Cent. Preference	11 5-16,	7-16	11⅜	11⅛
Great Northern	9⅛,	⅜	9 11-16	9⅝
Indo-European	24,	26	25⅛	25⅛
Mediterranean Extension	2¾,	3¼	—	—
Do. Eight per Cent. Preference	10,	11	—	—
Reuter's	10,	11	10⅜	10⅜
Submarine	233,	238	234	234
West India and Panama	1⅛,	⅞	1 13-16	1⅝
Do. Six per Cent. Preference	7¾,	8	7⅞	7¾
Western and Brazilian	7¼,	½	7½	7
West. Union Seven per Ct. 1st Mt.	120,	125	—	—
Do. Six per Ct. Sterg.	102,	104	—	—

TRAFFIC RECEIPTS FOR FEBRUARY, 1880.

Companies.	Feb. 1880.	Feb. 1879.	Incrse.	Decrse.
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	3,200 estd.	2,775	425	—
Direct Spanish Telegraph Company	—	—	—	—
Direct United States Telegraph Company	—	—	—	—
Eastern Telegraph Company	44,591	37,251	7,340	—
Eastern Extension Telegraph Company	25,190	22,409	2,781	—
Great Northern Telegraph Company	14,160	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—

ADDRESSES.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

PETER BROTHERHOOD, Engineer, 56 and 53, COMPTON-STREET, GOSWELL-ROAD, E.C.
Specialities—Patent 3-Cylinder Engines (Silver Medal, Paris), as used by Siemens, Gramme, and Wilde for driving Electric Machines.

RANSOMES, SIMS, and HEAD, Orwell Works, IPSWICH.
Specialities—Portable and Stationary Engines, fitted with patent governors, as tried in the electric lighting experiments on the Thames Embankment.

ABBOTT and Co., NEWARK-ON-TRENT.
Specialities—The "Standard Size" Vertical Cross Tube Boilers. Illustrated catalogue, giving every detail of a variety of Boilers 2s. 6d., post free.

CARBON ELECTRODES COMPANY. Works: 39, COMMERCIAL-ROAD, EAST.
Specialities—Carbon Rods of all sizes for Electric Lighting. Also, Plates and all other Moulded Carbon Goods. List of prices on application.

M. THEILER & SONS, Telegraph Instrument Manu-facturers, 86, CANONBURY-ROAD, N. Works: ALWYNE-LANE, N.
Specialities—Morses, Polarised Relays, Saunders' Curb Keys, Type Printers, Recording Sounders, Duplex Apparatus (Theiler's Patent).

HOOPER'S TELEGRAPH and INDIA RUBBER WORKS, MITCHAM and MILLWALL DOCKS.
Contractors for the Manufacture and Laying of Submarine Telegraph and Torpedo Cables. Manufacturers of Hooper's celebrated Insulated Core. Printed reports on application. Offices: 31, LOMBARD STREET, LONDON, E.C.

THE BRITISH ELECTRIC LIGHT COMPANY (Limited), 41, PARLIAMENT-STREET, WESTMINSTER, and 17, WATER-STREET, LIVERPOOL.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

ELECTRICAL AND SCIENTIFIC APPARATUS.—WHOLESALE MANUFACTURERS OF ELECTRIC BELLS.—Our new metallic base Electric Bell and Constant Battery Indicators and Telephone Switches. Induction Coils of highest finish; Terminals, Carbons, and all materials. Silver and Nickel Plating and Gilding. Instruments made, repaired, or altered on the premises. Illustrated Electric Bell list free. Complete catalogue two stamps. Special quotations to the trade.—DALE and CRAMPTON, Electricians and Opticians, 4, Little Britain, London, E.C.

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SLIP

THE BRUSH LIGHT.—This light is being used at Wabash, Ind., U.S.A.

A NEW Telegraph Cable is being constructed at Kurrachee for the Persian Gulf.

THE BERLIN ELECTRIC RAILWAY.—Permission has been granted to Dr. Werner Siemens to erect one electric railway between Wedding Platz and Belle Alliance Platz, without an intermediate station.

ELECTRIC CHLOROPHYL.—Our contemporary *Nature* gives the following epigram on Dr. Siemens' recent researches:—

Quis veterum vidit plantas sine sole virentes
Germinat en semen Siementis lumine claro.

THE ANGLO-AMERICAN TELEGRAPH COMPANY.—We have great pleasure in stating that Mr. H. Weaver, who for ten years has occupied the position of general manager of this company, has been appointed managing director.

THE AMERICAN UNION COMPANY.—The Dayton and South Eastern Railroad Company is now engaged in putting up a telegraph wire the entire length of the road. The line will be worked, it is understood, by the American Union.

THE DIRECT SPANISH TELEGRAPH COMPANY.—The thirteenth ordinary meeting of this company will be held at 106, Cannon-street, on Wednesday, March 31st, at three o'clock. The transfer books of the company are closed to the 30th inst.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY.—We are informed that the question of making the Blake transmitter is still *sub judice*, and by no means the foregone conclusion the Edison Telephone Company would have us believe.

CANADA.—The Montreal Electric Light Company will apply to the Legislature of the Province of Quebec, at its next session, for an Act of Incorporation for the Montreal Electric Light Company, with power to furnish in the city and district of Montreal, light and motive power generated from electricity.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts for the half month ending the 29th Feb. are £2,832, as compared with £2,200 in the corresponding period of 1879. Half month ending March 15, £3,488, as compared with £2,660. The Dec., 1879, receipts, estimated at £4,834, realised £4,855.

SWAN'S ELECTRIC LIGHT.—Mr. Swan, the anticipator of Edison's cardboard lamp, has had his researches interrupted for a time by a disastrous fire. His engine and magneto-electric machines escaped, though most of his lamps and other apparatus suffered. He is now aiming at the production of a permanent lamp on the incandescent principle.

COST OF TELEGRAMS.—The Postmaster-General announces that on and after April 1 the rates of charge to the principal countries in Europe will be as follows per word:—Austria, 4½d.; Belgium, 2d.; Denmark, 4d.; France, 2½d.; Germany, 4d.; Greece, 7½d.; Holland, 3d.; Hungary, 5d.; Italy, 5d.; Norway, 4d.; Portugal, 6½d.; Russia in Europe, 9d.; Spain, 6d.; Sweden, 5½d.; Switzerland, 4d.; Turkey in Europe, 8d.

A DISCLAIMER.—We learn with some surprise that our description of an incident which occurred at the last meeting but one of the Society of Telegraph Engineers has been misinterpreted. The use of the word gentlemen was, indeed, simply descriptive of the kind of amenities we were desiderating. Perhaps the sentence would have been sufficiently clear without that word; and as it appears to have given pain we regret that it was used.

AN ELECTRIC POST FOR PARIS.—Dr. Werner Siemens' plan of an electric post appears to be taken up by the Parisian postal administration. Electric telegraphy was recently superseded in that capital by a complete pneumatic post, but this in turn is, we understand, to give way to an underground electric railway on which diminutive electric locomotives will bowl along. One of these little engines will carry a load of 14lb. at the rate of 15 miles an hour.

"LA LUMIERE ELECTRIQUE."—The current number contains articles on "Telephonic Communication at Paris," by M. F. Geraldy; "An Application of the Telephone," by Carlo Resio; "The Conditions of the Strength of Electro-Magnets," by Comte Th. Du Moncel; "The Use of the Electric Light in Tunnelling," by E. Hospitalier; "Atmospheric Electricity," by D. Brooks; "Electric Light with the Tommasi Battery," by E. Hospitalier; "Notes on Recent Electrical Work," &c.

LUMINOUS PAINT.—We have on several occasions mentioned Balmain's luminous paint, an interesting substance which is finding a variety of useful applications. For example, it has been adopted as an interior paint for a railway carriage on the Great Western Railway to save oil lamps in passing tunnels. When excited by sunshine or the electric light its phosphorescence in the dark is very powerful, and reminds us of the "clotted" light and luminous foam of tropical seas.

HENLEY'S TELEGRAPH COMPANY.—The telegraph and other works of Mr. W. T. Henley, situate at North Woolwich, were taken over as from 1st instant, by Mr. W. T. Henley's Telegraph Works Company (Limited), who are carrying on the business as manufacturers of submarine and land telegraph cables, wire and appliances, galvanised corrugated sheets, galvanised strand fencing wire, &c., Henley's patent cores, &c. Mr. Henley retains considerable interest in the company, and his valuable services have been secured.

THE NEW FRENCH ATLANTIC CABLE.—The manager of the Paris New York Cable Company has issued a circular to the shareholders of that enterprise, in which he states that the expenses have not exceeded the estimates, that 7,000 kilomètres of cable have been laid down and are in excellent condition, that the reserves of the company are "important," that the service is organised, and that in a month the opening of the English lines will enable the company to participate in the entire Transatlantic telegraphic traffic. No figures, however, are vouchsafed.

THE NEW CABLE STEAMER.—The ss. Grappler, of the West India and Panama Telegraph Company, is now lying at the Silvertown Works for the purpose of taking cable and stores. She is of 868 tons burthen, and has three cable tanks placed amidships and fore. She has a raised quarter deck aft and bridge deck amidships. The crew are accommodated forward; the captain, officers, and electricians amidships, and the engineers and firemen aft, where the engines of 550 H.-P. are placed. The Grappler was designed by Messrs. McKaig and Still, Liverpool, and built by Mr. Laird, of Sunderland.

THE TELEPHONE IN COURTSHIP.—A telephone was established between the Palace of the Pardo, where the Archduchess Maria Christina was staying prior to her marriage, and King Alfonso's palace at Madrid. Mr. Edison had, in all probability, never dreamt of such an application of his invention; and this new manner of paying court to a fair

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lady will, no doubt, in future be frequently adopted in Spanish high life, so that the occupation of the duenna, to whose keeping the betrothed was usually confided till the day of marriage, will become, like many other occupations of bygone times, a tradition of the past.

Telephone Wires in Towns.—In compliance with the Mayor's order against the erection of telegraph or telephone poles in Cincinnati, the City and Suburban Telegraph Association stopped all gangs of men from working, and the matter has been taken under advisement by the Board of Directors of the Association. On the 27th ult. the Board of Aldermen rescinded the resolution under which the privilege of erecting poles was granted. New York and Chicago are agitating this question because wires in the streets are exceedingly troublesome in case of fire, presenting an almost insurmountable barrier to the erection of ladders.

The "Diaphote."—America has of late acquired an unenviable reputation as a land of bogus discoveries and sham nventions, a character which all who know how really great she is in practical science, and what the world owes to her, cannot but regret. She has her own citizens to blame for it, however. The "diaphote" is another great electrical discovery announced from there, and is nothing less than an apparatus which does for light what the telephone does for sound. As the telephone diaphragms vibrate in unison, so do the mirrors of the diaphote show a similar image. The inventor's name is Dr. H. E. Licks, of Pennsylvania.

Stewart's Lamp.—A new form of lamp for the electric light has recently been invented by Mr. Stewart, M.A. In this lamp a carbon rod of considerable length descends vertically through the centre of a metal tube formed into the shape of a ring, a piece of insulated carbon placed beneath the carbon rod preventing the latter from falling. The electric arc is formed between the inside edge of the ring electrode and the lower end of the carbon rod. There is a flow of water through the metal tube to keep the latter cool. The lamp is lighted automatically by an electro-magnet bringing the metal electrode momentarily into contact with the carbon rod.

Is it True?—Our contemporary, the *Engineer*, in a notice of Mr. Reid's work, "The Telegraph in America," concludes with the following:—"A valuable feature of this work is the vast amount of information given as to the cost of the American lines, the methods of working, and so on, enabling the reader to compare the administration with those of other lines. It will be strange if hints cannot be obtained from the material supplied, even for the better working of our own system. One fact, we think, is unmistakably shown in this book, and it is that the men employed in telegraphy in America take a much greater interest in all that concerns their duties than do those holding similar positions in England."

City Postal Improvements.—To-day a further important addition will be made to the postal facilities of the Eastern Central, or "City" district, by the opening of a new branch post-office at 43, Fleet-street, opposite Fetter-lane, in lieu of the office at 30, Fleet-street, known as the "Temple-bar" post-office. The new office, which appears to be on the scale of a district rather than a branch post-office, is conveniently situated to the Temple, Serjeants'-inn, and Chancery-lane, and will be open for postal business from 8 a.m. until 8 p.m. daily, and for telegraph business from 8 a.m. until midnight. The later hours during which telegrams may be forwarded are of importance in a neighbourhood like Fleet-street.

Electricity and Vegetation.—Touching the experiments of of Dr. Siemens, a correspondent of the *Journal of the Society of Arts* mentions the fact that in India the bamboo rarely puts forth its young shoots with vigour at the beginning of the rainy season until after the occurrence of a thunderstorm, which generally ushers in the monsoon; and the heavier the thunderstorm the more rapid is the growth. Bamboo shoots have been known to grow $2\frac{1}{2}$ feet in twenty-four hours, and 70 feet in thirty days, the greatest activity happening during the night. If this is so, not merely the light but the electricity developed by Dr. Siemens' process would seem to foster growth.

The Tyson Motor.—This little portable and ornamental motor, doing 1,000 foot-pounds of work per minute, might be found useful in the laboratory and elsewhere for driving small dynamo-electric machines. The *Scientific American* says that "it is a steam engine with a non-explosive steam generator, and without a steam gauge, water gauge, or safety valve, and its boiler or generator has but one-fiftieth the cubical capacity of an ordinary boiler adapted to the same engine." Either gas, coal oil or gasoline may be used as fuel; or, in the larger forms of the engine, wood and coal may be employed. When the gas is turned on, all that is necessary is to pour into the machine a few quarts of water every four or five hours. If this supply be omitted the engine stops, but cannot explode. A practical comparison of this motor with the best forms of gas engine would be interesting.

The Chalk Cylinder Battery.—Professor Barrett writes:—"When I sent my note to the Physical Society, announcing the production of an electric current by the friction of metal on a rovolving chalk cylinder (the only case I know where friction, or, at any rate, the relative motion of two dissimilar conductors in contact, generates a continuous electric current), I was unaware that Mr. Edison had already made a similar discovery. I was first informed of the fact by Mr. Johnson, the electrician to the London Telephone Company. Although I see *The Electrician*, in common with most of the other English journals, every week, the announcement of Edison's discovery escaped me, and I should be glad if you would refer me to its record in your columns or elsewhere, and I will take care to make an immediate disclaimer in the matter." [Professor Barrett then, with some justice, goes on to comment on the remarks in our Note of last week. If we say this, we need say no more on the subject.—Ed. *E.*]

An Electric Telemeter.—The principle of similar triangles has been ingeniously applied to measuring the distance of an inaccessible point, by M. Goarant de Tromelu. The problem is, given a base line with two observatories at its ends, to find the distance of a third lateral point from one of the observatories. The three points form a triangle, and it is clear that a similar triangle, on a small scale, can be got by drawing at one observatory, say O, a parallel to the line of sight between the other observatory O′, and the object. To draw this parallel M. Tromelu calls in the aid of electricity. He directs a telescope on the object at observatory O′, and by means of intermittent currents emitted in the act of alligning the lunette, he manipulates, by corresponding degrees, an index, or pointer, at the other observatory O, so as to keep it always truly *parallel* to the axis of his telescope. The similar triangle formed between this index, the line of sight between O and the object, and the direction of the base line O O′, is proportional to the great triangle on the ground.

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CHASSE'S MULTIPLEX TELEGRAPH.—For some months a Frenchman, named Chasse, has been promulgating the most astonishing claims with regard to an alleged new process of telegraphing, by means of which an indefinite number of messages might be sent simultaneously in opposite directions over a single wire. A few days ago practical telegraphers were invited to a demonstration of the process at the inventor's workshop in Hartford, Conn. There were eighteen telegraphic instruments at each end of the room, all connected with a single wire, supposed to represent a cross-country line. Eighteen messages were sent each way all at once, apparently on the single wire. Among the witnesses was Mr. W. Hadden, of the Western Union Telegraph Company, who noticed that the insulated connecting wires were neatly fastened to the wall by double pointed carpet tacks. On pulling one out, he found that beneath each tack the covering of the wire had been neatly cut away, and an ingenious system of false circuits established by fine wires leading from the tack legs. The supposed cross-country wire was a sham, and the too promising multiplex telegraph a clever cheat.—*Scientific American.*

THE SOCIETY OF TELEGRAPH ENGINEERS.—The following has been sent to all members of the society:—"Sir: The Council are of opinion that the present title of the Society is not sufficiently comprehensive to indicate the full scope of the objects for which it was established, viz., 'for the general advancement of *Electrical* and Telegraphic Science,' and that we consequently fail to secure the support not only of many of that large and increasing body of Electricians who, although not Telegraph Engineers, are professionally connected with other practical applications of Electricity, but also of those who pursue the subject from a pure love of Science. They, therefore, recommend that the title shall be 'The Society of Telegraph Engineers and Electricians.' The Council are desirous of giving every member and associate the opportunity of expressing approval or disapproval of the proposed change before submitting the matter formally to a general meeting, which they purpose doing in November next; and I am accordingly instructed to request that you will favour me as soon as possible with your views on the enclosed form of reply, in which a blank space is left for the insertion of the word *not* in the event of your dissenting from the proposal."

"THE JOURNAL OF THE SOCIETY OF TELEGRAPH ENGINEERS."—We are glad to see in the current number the commencement of the system of abstracting we have so often suggested as a means of making the *Journal* of still greater value than when simply recording the papers read before the society and the discussion upon such papers. The following is an illustration of the manner in which these abstracts are done. It is, we should say, the shortest of the five abstracts given in the number:—"Aluminium for Telegraph Lines (*Les Mondes*, No. 6, February 5th, 1880, p. 251): Experiments have recently been made by the German Telegraphic Administration regarding the employment of aluminium in place of iron wires, in consequence of aluminium having twice the conducting power of iron. Of course the high price of the former material would prevent the line wires being made entirely of that substance, but experiment has shown the possibility of making an alloy of iron and aluminium, which, although containing but a very small percentage of the latter substance, has a high conductivity, and so the line wires may be made of smaller diameter than before. The alloy is also tough, and better able to resist the destructive action of the atmosphere than iron."

POST OFFICE TELEGRAPHS.—The accounts of the Post Office Telegraphs for the year ended 31st of March, 1879, have just been issued. The capital account shows that the amount of capital raised to 31st March, 1879, was £10,140,000, and that £348,658 of further capital would be required, if all expenditure in the nature of capital had been charged to the telegraph account. This makes a total of £10,488,658. The amount paid for goodwill and plant of old telegraph companies, extension by the Post Office, preliminary expenses, &c., and charged to the telegraph capital account, up to 31st March, 1879, was £10,121,575; cost of extensions charged to telegraph vote to same date, £156,468; cost of sites and buildings, ditto, £122,419; cost of buildings, &c., charged to vote of office of works, London, to same date, £67,368; cost of buildings, &c., charged to vote of office of public works, Dublin, to same date, £20,828; total, £10,488,658. The account of revenue and working expenses shows the revenue to have been:—Messages, receipts, private wire rentals, &c., as per finance accounts, 1878-79, £1,333,726; value of services rendered to Government departments, without payment, £20,603; extra receipts, £15,139; total, £1,369,468. There was paid for salaries, wages, maintenance, &c., £1,096,893; contribution to a depreciation fund to replace submerged cables, £12,103; balance of profit (equal to 2·48 per cent. on a capital of £10,488,658), being the full amount available on commercial principles for dividend on capital, or for a reserve fund, £260,472; total, £1,369,468.

MARINE SAFETY SIGNAL.—Captain William Barker, of New York, suggests, as many have done before, the introduction of the Morse system of telegraphy at sea. His system reduces the total number of letters to be learned to eight, each letter representing one octant of the compass. It is very truly remarked that collisions on the open sea, where vessels have room to move in any direction they may see fit, seldom occur in the daytime, because the ships are in plain sight of each other; the course each is steering is well known, and each commanding officer has time to make and execute his plan for working his vessel, and knowing exactly the whereabouts of his danger, and the line on which it is moving, he easily avoids it. By the judicious replacement of sight by sound Captain Barker gives the commanding officers equal security in the densest fog. A fog horn of improved construction is so mounted that the mouthpiece can be instantly brought into connection with either octant of a dial plate indicating the eight principal points of the compass, and whilst the mouthpiece is set to any given octant only the signal corresponding thereto can be sounded. The signal consists of a succession of long (*l*) and short (*s*) sounds; so that the signal will be for any course from—

N. to N.E.	= *l-s-s*	S. to S.W.	= *s-s-l*
N.E. to E.	= *l-s-s-s*	S.W. to W.	= *s-s-s-l*
E. to S.E.	= *l-s-l*	W. to N.W.	= *s-l-s*
S.E. to S.	= *l-s-s-l*	N.W. to N.	= *s-s-s-s*

On a steamer the blasts are made with her whistle, which is connected with the machine by wire or line; on a sailing vessel the blasts are made by a fog horn attached directly to the machine itself. The courses are indicated and the corresponding orifices representing the blasts are made on the dial plate. The man on duty has merely to continue to turn the crank slowly and steadily; the lower cylinder rises and compresses air in the upper cylinder, which at the same time begins to revolve the proper signal for the given octant being sounded. Upon the $\frac{1}{8}$th revolution being completed the crank gearing disengages itself, and the whole concern resumes its normal position ready to repeat the signal. The same signal will be repeated until the position of the indicator is changed.

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DETERMINATION OF CHEMICAL AFFINITY IN TERMS OF ELECTROMOTIVE FORCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is stated, p. 189, in *The Electrician* of the 6th inst., that Dr. C. W. Wright read before the Physical Society an "important paper" on this subject. It is also stated that he gave a history of the subject, but not having, as yet, seen the paper, I do not know whether what I am about to say found its place in that history. At all events, I feel it is only due to myself to call the attention of Dr. Wright and others to the fact that this matter was fully worked out by myself in a series of articles which appeared in that widely circulated scientific paper, the *English Mechanic*, in 1871, and which formed the chapter on "Electromotive Force" in my book "Electricity; Its Theory, Sources, and Applications," published in 1875, and itself pretty widely circulated, seeing that 1,700 copies have passed into the hands of the public.

I believe I may claim as my own the definite idea of the actual identity of chemical affinity and electromotive force, and the possibility of definitely expressing the former in the easily ascertained terms of the latter, and I gave the means of doing this and the means of converting one into the other either from experimentally measured electromotive forces, or from experimentally measured chemical forces (such as the heat of combustion). General ideas had been previously expressed by many as to these relations, such as between the forces of batteries and the oxidations, &c., effected therein; but I showed the definite connection, and proposed a unit of conversion, the equi-volt, which in some of its possible forms, would be a perfect unit for all forces and forms of energy. I feel some interest in this, and so claim my rights in the matter, because I have felt that it effectually settles the whole dispute as to the chemical and contact theories, and puts the latter in the famous condition of Humpty Dumpty, beyond the repairing powers of all the mathematicians, and all their cabalistic formulæ.

Dr. Wright has experimented with the decomposition of water (so called), and brings out the force as 1·5038 volts. I gave it, in the places mentioned and p. 222 of my book, as 1·464. Dr. Wright considers that, from his determination, certain corrections require to be made in Joule's equivalent, and compares the values arrived at by different experimental processes. I should suggest that no experimental results, when dependent upon many varying conditions, all subject to error, can be compared in value with those arrived at from sound theoretical considerations. The actual equivalent is attainable from the ratio of the heats of constant volume and pressure of gases, and from the transmission of sound in different densities of air, more correctly than from any experiments specially devised for the purpose. As to the difference between my value for water and that of Dr. Wright, it seems very doubtful if either is really correct. My own was avowedly an approximation based upon the measurement by Favre of the heat of combustion of hydrogen, and subject to other probable corrections; but it appears to me that Dr. Wright's value is too high; that his determination of the electromotive force includes that absorbed in the resistance of his voltameter as well as that represented in the work of decomposition.

While in the act of reclamation, I may also remark that in the No. of February 28th there is recorded a paper sent to the Society of Telegraphic Engineers, on the 25th, by Mr. J. B. Stearns, on some defects in differential galvanometers and the possible remedies. Every one of those matters is mentioned p. 135 of my book. But that is nothing. J. T. SPRAGUE.

TECHNICAL PHYSICS.*

No. III.

We have spoken of the tendency a battery has to produce an electric current, which tendency is called its *electromotive force*. To understand this better we must learn that there are two kinds of electricity, and that it is the desire of these two to rush together and combine, which produces this electromotive force. If I rub a piece of glass on my coat you see what most of you already know, that it attracts the bits of paper lying on the table. If I produce electricity in much larger quantities by means of this electrical machine, then not only are the bits of paper, pith, &c., attracted to the metal plate hanging from the prime conductor of the machine, but they are repelled again, producing a bombardment of electrified particles bstween one metal plate hanging from the machine, and the other resting on the table. Now, it is desirable to examine one of the bits of pith after it has been repelled from the upper plate, and for this purpose we attach a small pith ball to an insulating stand. We have said that wood, bone, glass, &c., are insulators; by that we mean there is difficulty in causing electricity to pass through them, but there is another way in which electricity can pass along a glass rod besides passing through its mass, and that is along its surface. On the surface of almost everything lying on the table before us there is moisture and dirt, which conducts electricity, not nearly as well as a metal it is true, but far better than glass. And this is the reason why a piece of glass rubbed on your coat hardly shows any signs of electrification on damp days unless you take special care previously to dry the glass and your coat. The electricity is really produced as much on a damp day as on a dry frosty one, but on the damp day it is lost, conducted away as rapidly as it is produced. The experiment I now try before you, first using a clean, dry glass rod, next the same rod rubbed with my damp hand. In order, then, that a glass stem may insulate properly it is necessary that it should be clean and dry. A servant says a wine glass is clean when it looks so to her eye, but often such a glass is chemically horribly dirty. A fine polish of grease is spread over the surface of the glass, causing it to shine and insulate electricity very badly. In the same way some of the most sparkling water is chemically the most impure and the most poisonous. Chemistry has some very delicate tests for cleanliness, but I think there is no doubt that the electric tests are really far more delicate. To clean the glass we first use acid to dissolve away some of the dirt, we use hot water and soap to remove the grease, next hot water to remove the soap, and finally distilled water, that is water formed by condensing steam, to wash off the salts that are always found dissolved in ordinary water. Having got our glass rod clean, we next dry it, not by rubbing it with a cloth, which would certainly dirty it again, but by putting it near a fire. It will then insulate very well, but as soon as it grows cold, it will, if left in the open air, begin to become damp again. The simplest way is to keep the rod in a space artificially dried. Certain substances, calcium chloride, sulphuric acid, phosphoric acid, &c., have a peculiar power of sucking the water out of the air. One body, common salt, you well know, has that property, and that is why it is so difficult to dry a cloth wetted in salt water, and why it is better to first rinse it in fresh water.

This glass jar has a vertical glass rod fastened to the base inside it, and closed by a cork with a hole in it, only just large enough to allow the glass rod to pass through without touching. At the bottom of the jar there is a little sulphuric acid. The effect of this acid is to dry the space inside, and hence the glass rod is constantly kept in an artificially dried atmosphere. Now, if I rub a piece of glass on my coat, and hold it near a pith ball, suspended by a piece of silk from a hook formed in the glass rod, the pith ball is first drawn to the glass rod, but after touching it the ball flies away, and evades the rod. In the same way, if we put a large charge of electricity into this brass ball, which is attached to a Leyden jar, or electrical reservoir, we find that we can, by electric repulsion, keep, as you see, a feather floating in the air. We rub our glass rod again, and approach it to the suspended pith ball; we find still repulsion, showing that the ball has held its charge. Now let us rub a piece of sealing wax, or better still a piece of ebonite on a piece of flannel, or better, on a piece of cat's skin, and hold it near the pith ball that is repelled by the rubbed glass. We see that first attraction takes place, then the pith touches the ebonite, and lastly the pith ball flies off from the ebonite, just as it did originally from the glass. While the pith ball is evading the ebonite let us bring up our rubbed glass rod, and at once we see the ball flies to the glass. These experiments show us that rubbed glass and rubbed ebonite behave differently, and for convenience of expression we say the former is charged positively and the latter negatively, and that similarly electrified bodies repel, similarly electrified attract one another. For really whenever two bodies are rubbed together, or indeed when two bodies are even touched together and separated, one is found charged positively, and the other negatively, and every experiment shows that the amounts so produced are always exactly equal in quantity. The production of electricity by rubbing is simply due to the contact and separation of dissimilar substances, but as the substances employed are insulators, it is necessary, if a large quantity of electricity be required, to make contact successively in a large number of places, and rubbing is the simplest method of doing this. When the glass is rubbed on my coat it is the glass that is charged positively and my coat positively. My coat, however, not being an insulator, it loses its charge at once, and I, therefore, cannot detect that it was charged. If, however, I put an insulating handle on the cat's skin with which I rub the ebonite, then you see that when the insulated pith ball evades the ebonite it flies to the insulated cat's skin; in fact, while the ebonite is charged negatively the cat's skin is charged positively. From what you have seen you would expect that if we have two insulated pith balls, both charged with the same kind of electricity, that they will, as you see they do, repel one another, and experiment shows that the amount of repulsion depends on the quantity of electricity with which they are charged. Our first instrument for measuring electromotive force, the Peltier Electrometer as it is called, simply depends on this principle. A horizontal wire, made of aluminium, which is the lightest metal known, turns on a pivot. When the instrument is uncharged this wire, by means of a small magnet attached to it, naturally comes to a position of rest against a horizontal rod of brass rigidly attached to the pivot on which the aluminium needle turns. The brass rod and the aluminium wire, therefore, are in metallic connection with one another, but the whole is insulated from the ground by an ebonite pillar. Now, if I communicate a charge of electricity to the brass rod and aluminium wire by touching the brass knob at the top of the instrument with some charged body, the wire and the brass rod repel one another, and as a result the wire is deflected through a certain angle. The amount of deflection is a measure of the charge of electricity communicated to the rod and the wire. I do not mean that twice the deflection is produced by twice the charge, but only that increasing the charge increases the deflection, and diminishing the charge diminishes it. The deflection, then, is a direct indication of the charge; indirectly, however, the deflection measures something else, and that is the electromotive force between the brass ball or the charged conductor held in contact with it and the outside of the glass case of the electrometer. Under ordinary circumstances, this outside of the glass is, like all other bodies on the table, coated with moisture, so that it is in connection with the earth electrically, in fact forms part of the earth. Consequently, we may say that the deflection of the wire of the Peltier electrometer is a measure of the electromotive force between the earth and the knob, or the electrified conductor held in contact with it. The knob or the body held in contact with it I said, but are we sure we may talk of one or the other, may there not perhaps be an electromotive force existing between the two? If you remember what electromotive force means, you will see this cannot be the case, for there can be no tendency for electricity to flow from the knob to the body, or the body to the knob, since if there were this tendency

* A Course of Lectures on "Some of the Practical Applications of Electricity and Magnetism." Delivered by Mr. Ayrton, at the Technical School, Cowper-street, of the City and Guilds of London Institute.

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then a flow would take place. A flow, no doubt, does take place when the charged conductor is first brought up to the knob, but this only lasts for a fraction of a second. Subsequently, there is no flow, the electricity remains at rest, and being no flow and no tendency for a flow, there cannot be any electromotive force between the knob and the charged conductor in contact with it. In fact, we may say as a general rule that whenever electricity is at rest on a conductor composed of one metal all at the same temperature there is no electromotive force between any one point and any other point of the conductor.

Let us now try a few simple experiments with this Peltier electrometer. I rub a rod of glass on a piece of silk, and bring the glass near the electrometer—the aluminium wire is deflected. Why? Because the positive electricity in the glass attracts negative electricity out of the horizontal rod and wire into the ball, or both the former become positively charged. I remove the rod—the wire goes back to its original position. I bring up the rod again, and touch the knob of the electrometer—the wire is again deflected. On taking away the glass rod, the wire appears to remain stationary in its deflected position. I now rub a piece of ebonite on flannel, and bring it near the knob—the deflection of the wire rapidly diminishes. Why is this? Because the ebonite is charged negatively, and negative electricity attracts positive electricity, so that some of the positive electricity previously in the brass rod and the aluminium wire is attracted up into the brass knob. The charge in the brass rod and wire is diminished, so, therefore, is the deflection. The electromotive force between the knob and the earth is also diminished, for before bringing up the ebonite rod there was a tendency for positive electricity to flow from the knob to the earth. This tendency has been diminished, has been resisted in fact by the attraction of the negative electricity on the ebonite for the positive in the ball. Consistently, therefore, with what we said before a diminished deflection indicates a diminished electromotive force between the knob and the earth. I now touch the knob with my finger—the aluminium wire instantly swings back to its original position alongside the brass rod, the knob has been connected through my body, a conductor, with the earth. There cannot, from what we have previously seen, be now any electromotive force between them. I bring up the rubbed ebonite—still no deflection—and for the same reason; I take away my finger—the wire is still at rest. We now move the ebonite either nearer to or farther away from the knob, and a divergence takes place. Moving the ebonite must then charge the brass rod and wire. As long as the knob is connected by a conductor with the earth there is no charge in the horizontal brass rod and wire, but the presence of the rubbed ebonite causes a positive charge in the ball. When, after I have removed my finger, I take the ebonite rod further away, some of this positive electricity flows down into the horizontal rod and wire, or they become positively charged, and therefore repel one another. When I bring the ebonite rod nearer more positive electricity is attracted up into the knob, or the rod and wire repel one another because they become negatively charged. And so on with a great many more interesting experiments which you should all try for yourselves, and endeavour to understand the reasoning of.

We have repeatedly spoken of the electromotive force between a body and the earth, which is somewhat analogous with the height of the body above the ground, but in ordinary conversation, for brevity's sake we drop the expression "the ground," and merely talk of the height of a building, a tree, a man, &c. So in electricity we speak of the potential of this brass ball, of that plate of metal, when what we really mean is the electromotive force between the brass ball and the earth, or between that chain and the earth. The electromotive force, then, between any two bodies you would say must be simply the same as the difference of potentials between them. This conclusion, although not absolutely accurate, is quite near enough the truth for all our present purposes. When, therefore, we speak of a body having a high electric potential we do not mean that it has necessarily a large charge of electricity in it; what we do mean is that the tendency for an electric discharge between it and the earth is large. This is almost analogous with saying that the pressure of water in a cistern or gas in a reservoir is great; we do not necessarily mean there is much water or much gas. That may or may not be. All we desire to imply is that if we do not take care, and make our cistern or our reservoir strong, there will be an accident from bursting. This long, narrow, vertical tube full of water has but little water in it, and yet the pressure on the bottom, the tendency of the bottom to break, is large. If I now open the stopcock at the bottom but little water altogether flows out, and yet, the pressure being great, the water spirts all across the table at the moment of opening the cock. In exactly the same way the quantity of electricity produced by this frictional electrical machine, or by this Holtz machine, is small, so that if we connect the prime conductor with the ground by a thick wire, with one little bit of very fine wire inserted in its length, we may have the machine as dry and in as good working order as is possible, and we may turn as hard as we like but we shall never make the wire red hot, we shall never even perceptibly warm it; in fact, as you see now, the current produced by the machine produces no deflection with even this fairly sensitive galvanometer. But if we turn the machine without the wire on the prime conductor, which is like filling our long tube with water with the stopcock shut, and if we then bring our finger near the prime conductor we receive a spark several inches long, or if we connect the prime conductor with the knob of the Peltier electrometer, the slightest turn of the handle produces a large deflection. Now, let us take the other case—a large quantity of electricity and small electromotive force. The current from this small battery can, as you know and as you again see, heat this piece of wire white hot, and yet, if I try and get a spark, I may put the ends of the battery wires nearer and nearer together till they practically touch without seeing any trace of a spark. Or, again, when I now measure the electromotive force of the battery with the Peltier electrometer, we observe no deflection; the electromotive force is too small to be measured with so rough an indicator of electromotive force. This larger cistern, with the water at a small depth in it, is exactly analogous with a galvanic battery; if I open the stopcock, there is a considerable flow of water, but the distance over which the water spirts is but a fraction of an inch. Again, if I connect the long, narrow, vertical tube with the cistern by a pipe, and open the stopcock, which way will the water flow? from the tube, where the quantity is small but the depth considerable, into the cistern, where it is the depth that is small while the quantity is great; or will the flow be in the opposite direction? Opening the stopcock, experiment shows that the flow is from the place where the pressure is high to that where it is low, quite independently of the quantities, for we see the coloured water in the tube beginning to colour that in the larger reservoir. And so with electricity. If two conductors, made of the same metal, and at the same temperature, have different potentials, there is always a tendency for positive electricity to flow from the place where the potential is high to the place where it is low, quite independently of the amount of the electric charges in the two bodies.

When ringing an ordinary bell, we have seen that a certain quantity of food is burnt up in one's body as an equivalent for the work done in ringing the bell, whereas, when a battery is employed, we merely use a key or trigger for firing off the energy of the battery arising from the burning of the zinc. The objection to the first method of calling attention—using the common house bell—is the stretching of the wires, in consequence of which they get slack, so that, especially when the bell is far from the handle, and, when there are many cranks employed, one often finds that pulling the handle as hard as one likes produces no results for one's exertions. To the electric bell with a galvanic battery there is also this objection, that, if the wires are very long, the bell will not ring very loud unless the battery is large, because much of the energy of the battery goes in heating the wires, and keeping a large battery in order is a little troublesome. In addition, even if the proportion of electricity lost by leakage were merely a constant for any given wires conveying the current, it is clear that the stronger the current the greater would be the absolute loss of electricity, or the greater the absolute waste of material, since, for example, one tenth of a large quantity of electricity is much larger than one tenth of a small quantity. Experiment, however, shows that the percentage of loss on any given circuit conveying a current actually increases as the current is increased in strength, so that if, for example, one tenth of the whole quantity of electricity flowing were lost when the current was small, then, if the current were much increased in strength one ninth of this larger current would perhaps be the waste. The leakage from a telegraph line is, then, somewhat like that from an india rubber bag with a hole in it. If the pressure on the liquid or gas inside be increased, then not only will there be more leakage per second because the contents is forced out more quickly, but also because the increased pressure will make the hole bigger.

This difficulty of having to use a large galvanic battery at the signalling end of the line has been overcome in a variety of ways, electrical and mechanical.

Because we sometimes require to use a large army in India, we are not compelled on each occasion to send out the large force from England. We recruit our force from the native population in the country, and only set it in motion by despatches from London. Just in the same way, because we desire to use a considerable power at a distance to ring a bell or fire a gun with, there is no necessity for the whole of the energy to be transmitted mechanically or electrically all along the route. Suppose, for example, the electric current we send does not ring the bell at all, but only gives a slight motion to the delicately poised armature of a distant electro-magnet, it may not require much power to do this, and yet that small motion of the electro-magnet may be quite sufficient to close the circuit of a large *local battery* close to the bell or gun, and which produces the required signal. Do not forget that although a single motion of a piece of metal through the fiftieth of an inch may produce very little direct effect on the eye or ear, it it is sufficient to close the circuit of a large battery, and so bring about striking results. This device of calling into play a *local battery* constitutes Sir Charles Wheatstone's *relay*, of which you see some modern specimens in action before you. Another method of accomplishing a similar result is to have clockwork attached to the bell, which is wound up, of course, by the person in charge of the bell; then the weak current sent from the distance only liberates, by electro-magnetism, a detent, and allows the clock to ring the bell, as you now see it doing. Here the electric current does exactly what the going portion of a clock does relatively to the striking portion. The time keeping portion of a clock does not strike the hours, it only allows the spring, or the weight, of the striking portion to come into play at the right time.

The labour of ringing this bell is, then, not done by the person sending the signal, nor by the battery, but by the person in charge of the bell at some previous time when he wound it up. But winding up requires a certain amount of attention. If you do not wind up your watch it stops; but at any rate it will soon tell you that you have not wound it up, whereas one of these bells may not ring either because the man at the other end of the wire does not wish to call your attention, or because you have put it out of his power to call your attention by forgetting yourself to wind it up. It may be impossible, then, for him to send you a signal at some very important time. The following is an ingenious device for overcoming this difficulty, and can be used when two people are signalling equally often, each to the other, by ringing a distant bell. Each time I press down this handle I perform two distinct operations, the one to close a circuit and allow an electric current to flow to the other end of the line, the other to do a little towards winding up the bell close beside me by means of a paul and ratchet wheel attached to the key. The clockwork of one bell, then, is wound up a little every time a current is sent to ring the other, just as some watches are wound up by the action of constantly opening and closing of the case, to see the time during the day.

In my inaugural lecture I explained experimentally Faraday's discovery of electro-magnetic induction, and I showed you how an electric current could be produced by the relative motion of a magnet and a coil of wire. Clearly, then, we may use this invention for ringing a bell, and dispense with galvanic batteries altogether. When I press this handle down *sharply*, to do which you observe some exertion is necessary, you hear the bell at the other side of the room ring once. As far as the labour is concerned this method is nearly as laborious as pulling an ordinary wire, since the energy employed in ringing the bell is supplied by my hand, but it has the advantage that stretching of the bell wire cannot prevent the bell ringing satisfactorily, and the plan can, of course, be used at distances where ordinary pull bells would be impossible. But this plan of generating an electric current by the motion of the key can be naturally combined with a relay or clockwork at the other end of the line, somewhat similar to that employed with weak galvanic currents. In fact, this bell attached to Wheatstone's A B C dial instrument is an example of a bell rung by clockwork started by a weak electro-magnetic current generated at the other end of the line by the exertion of a small amount of muscular energy on the part of the signaller.

(TO BE CONTINUED)

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NEW WORK FOR ELECTRICIANS.

The extension of the applications of electricity is naturally a matter of interest to all electricians and electrical engineers; and to many amongst us this extension must be of personal moment, and our interest, therefore, something more than an abstract sentiment. For, however gratifying it may be to know that our beautiful science is making rapid advances, there is some satisfaction also in the thought that, as a profession, it is obtaining increased scope and consequent importance. Those who entered this profession mainly or wholly from a love of science, and who, after much labour, directed with more or less ability, feel that science has been mainly or wholly its own reward, will be best able to seize the purport of our present observations. Amongst the professions, that of the electrician has been, comparatively, a small one; and history will, we think, support us in the assertion that it has been overcrowded, rather than under supplied, with ability which, in many cases, has not found any adequate practical outlet. Now, however, the developments of applications of electricity in unexpected as well as in anticipated directions would seem to afford a prospect in which practical ability may find a wide sphere of action, and in which the demand for such ability could scarcely be met by our foremost men alone. But we think it is of importance that electricians and electrical engineers should meet this demand half-way, and lay themselves out in some measure for the work which they are qualified to carry into effect.

The application of electricity recently suggested, and in great measure demonstrated, by one of the greatest and safest authorities on such matters—Dr. C. William Siemens—is of a nature to merit our careful attention, and possibly, we may even say probably, to encourage the most enterprising and strenuous endeavour on the part of practical workers. Electricity, in the first place, has been introduced to Horticulture and Floriculture; and, strange as the association may at first sight appear, it is impossible to deny, and it would be difficult to limit, its prospective advantages. And if the man who causes two blades of grass to grow where one only previously existed be a benefactor to society, the same may surely be said of him who can cause fruits and flowers to thrive where hitherto they have failed from want of light and loss of heat by radiation, and who can bring two sciences or two arts into partnership where one alone was insufficient. We would fain also introduce to each other a society — we may shortly be able to say *the* society — of Electricians and the Royal Horticultural and Botanic Societies; for this would be a step towards the association of electricians with horticulturists, and towards the more speedy solution of problems which sooner or later have to be solved in practice. The art of electric lighting having been introduced to that of fruit and flower culture, the next thing to be done is to bring widely into contact the representatives of these arts. A sufficient inducement for immediate tentative association might, we think, be found in the following paragraph alone. "I expect," says Dr. Siemens, "that electric light may be usefully employed in front of fruit walls, in orchards, and kitchen gardens, to save the fruit buds at the time of setting; and in this application electric light will probably be found a useful agent not only to promote rapid growth, but to insure a better yield of fruit." If this be insufficient to bring the horticulturists to us, then, in spite of professional reticence and etiquette, it would be well for us to go to the horticulturists, ascertain precisely their needs and requirements, and let them understand clearly what we can do for them. For this newly-suggested application of electricity, if practicable at all—and we have already some good grounds for considering it to be so—is practicable on a very large scale, and should not be wholly neglected even for a single year. The demand, on the one hand, for English grown wall fruit, and for early vegetables and flowering plants of more than average quality and vividness of hue, is so considerable, and the effect, on the other hand, of cutting winds, deficiency of sunlight, and nocturnal radiation, is so detrimental in our climate to some of the most valued and potentially fertile of our plants, that there is great probability of successful results from the application of electricity now referred to.

It may be of considerable interest to refer to the effect of the electric current in the production of heat, as well as in the production of those actinic rays, under the influence of which chlorophyl is produced, and vegetable life is activated. Dr. Siemens rightly points out that the amount of heat given off from the electric arc is not great as compared with that from a gas-flame giving off its products of combustion; but his paper contains also the important observation that, in his experiments, no hurtful effect on the plants was produced by the want of ventilation. When the labour and difficulties encountered by the horticulturist in maintaining

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a due temperature are fully considered, the fact that heat of a peculiarly utilisable character accompanies the production of the electric light appears of considerable importance. Nor is the absolute quantity of this heat so small as to render it practically negligible. Taking the data furnished by Dr. Siemens in the sixth paragraph of his paper, it would appear that the heat generated per hour in the electric circuit by the expenditure of 2 horse-power was 5,980 calories English, that is to say, a heat sufficient to raise the temperature of 5,980lb. of water 1° Fah. And the utilisable heat, or that generated in the external circuit, was sufficient to raise 24·71b. of water from the freezing to the boiling point. To utilise this heat, together with the light, in the most advantageous manner is a problem not unworthy of the consideration of those in whose hands science is made to minister to the necessities and requirements of an advancing civilisation.

Another application of electrical agencies, suggested by Dr. Werner Siemens, is that of electric traction on aerial and underground railways in large towns. A translation of the original paper, partly in reference to this subject, which was read by the above eminent physicist before the Electrotechnical Society of Berlin will be found in our issue of February 7th of the present year. Those who have travelled on our underground railways, and have breathed the poisonous atmosphere loaded with sulphur dioxide, and those who have noted the constantly increasing plethora of traffic in the main streets of London, will be inclined to welcome this suggestion, in the carrying out of which the electrician and electrical engineer must necessarily be largely called into requisition. It is for them to consider whether the plan is, or can be made, thoroughly practicable from the points of view both of efficiency and economy, and, in the affirmative case, to place themselves in a position to aid in carrying it into effect. And through them, mainly, can the public be brought to understand and to bear in mind that there is a fresh direction in which electricity may beneficially be pressed into the service of practical life. The experiments on ploughing by electricity which were made at Sermaize by MM. Chrétien and Félix gave results which have an instructive bearing in this direction, where motion may be said to be converted into electricity, and electricity afterwards reconverted at a distance into motion.

Lastly, the various questions in relation to the substitution for "galvanised" iron, on overground lines, of an alloy of aluminium possessed of comparatively high conductivity, tensile strength, and chemical unalterability constitute at the present moment subjects which should receive full consideration on the part of electricians, since they are likely to be usefully brought within the domain of their practical professional work.

UNITED STATES AND CANADIAN TELEGRAPHIC AND ELECTRICAL NOTES.

As the Government has not yet assumed the ownership or control of the telegraphs in the United States or the Dominion of Canada a telegraphic monopoly is an impossibility. In the States, at least, it is not probable that a Government telegraph will soon be established. The project has never been popular, for the reason that the public is better served by corporate than it is believed it would be by Government management, and, furthermore, the jealousy and distrust of political parties toward each other is so deeply rooted that neither is disposed to trust the other in control of this vitally important means of communication.

The Western Union Telegraph Company has never succeeded in establishing a complete telegraphic monopoly, although it controls the larger part of the telegraphs of the country. Local companies affiliated with the Western Union occupy certain sections of the country, notably the North Western Telegraph Company, which covers a large section of the north-western States, upon which the Western Union has not attempted to intrude. The latter company has also to meet constant efforts to establish competing lines upon the territory which is covered by its own system. Thus far it has succeeded in practically absorbing these lines and companies into its system, although usually at a considerable cost, and after expensive competition and cutting of rates. Since obtaining control of the Atlantic and Pacific Company about two years ago, it has until recently had no important competitor to cope with. Within the last year, however, a new enterprise has been organised, which promises to prove troublesome, at least, for a time. This is called the American Union Telegraph Company. Its head-quarters are in New York, and it is backed by a party of large capitalists and speculators. In establishing these new companies their promoters do not propose to depend upon making money out of the telegraph business *per se*, but look principally for their reward in profits of construction, which are capitalised at an excessive amount, and from speculations in the shares of the Western Union Company, of which large amounts are daily bought and sold on the Stock Exchange. This fact makes them more troublesome to deal with than they otherwise would be.

The American Union commenced business and opened its general office in this city a few days ago. It claims to control about 30,000 miles of line in the States and Canada, a major part of which, however, it gets by building lines to connect a number of railroad and short lines already in operation, and by its lease of the Dominion Company's lines in Canada. Thus far it has not attempted any reduction of rates, except in Canada, but it is expected will do so when it is better prepared to handle the larger amount of business which such reduction would probably bring to it. The Western Union Company has for some time been quietly preparing to meet and cope with this new competition, and no doubt is expressed by the managers of the company of the ultimate result in their favour. The additional demand caused by this increase of telegraphic facilities for telegraphic labour has enabled the *employés* to obtain larger compensation, and, for this reason, they are much pleased with the change in the condition of affairs, which measurably has relieved them from their dependence for employment upon a single company.

The latest scare of the holders of gas stocks from the much-vaunted and advertised alleged discoveries and inventions of Mr. Edison has entirely subsided. It was never so extensive and severe in this country as it appears to have been in England and Canada. The repeated failures to substantiate the assertions of the practical value of Mr. Edison's labours and genius have caused a revolution in the popular feeling in regard to him, and instead of the extravagant and absurd eulogistic statements which a short time ago filled the columns of the Press, disparaging and sarcastic comments occupy the columns of the newspapers, generally, which notice him or his works at all. It may be said that scarcely a single person at all versed in electrical science here has credited his reputed discoveries. They have not, as a rule, come out openly against the pretentions of Mr. Edison or his injudicious friends, but have chosen rather to preserve a discreet silence. Instead of being actuated by jealousy, as has been charged, the American electricians have, on the contrary, appeared very kindly and cordially disposed to "give him a fair chance." They knew that he was spending a vast amount of time and money in repeating old experiments, but hoped that he might eventually get out of the woods and really make some valuable discoveries and inventions. There has been, however, so much charlatanism and puffing in connection with his operations that intelligent people are becoming pretty thoroughly incredulous, not to say disgusted with the operations at Menlo Park. The company which furnishes the means for making these multitudinous experiments appears, notwithstanding their as yet large and profitless outlay, to have full faith in ultimate success, and the experiments still go on, regardless of cost.

While the other electric light promoters have been spending time and money in trying to develop some startling novelty, the company which manufactures and introduces the Brush Electric Light have been quietly at work, and have built up a large and profitable business in a limited field. The Brush Light appears to be on the whole the best adapted to meet the existing demand, and the larger portion of the lights actually in use in this country are of the Brush pattern. They are reported to give satisfaction to those who employ them, mostly manufacturers and others who have large spaces to light. In this particular application the electric light is apparently destined to prove a success.

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ELECTRIC LAMP TESTS.

A correspondent of the *Scientific American* points out that the Annual Report of the United States Lighthouse Board for the year ending June 30, 1879, contains an appendix that will prove valuable to all that are interested in the study of the electric light, the different methods by which it is generated, and their relative merits and disadvantages. It contains a very full list of the appliances devised in recent times, with concise descriptions of the apparatus and principles involved illustrated by excellent cuts, some of which have appeared in the columns of the above-mentioned periodical, whilst others have been taken from Dr. H. Schellen's recent work. Its compact form renders it very convenient for reference. This portion of the report had its origin in a suggestion made last fall by the chairman of the Lighthouse Board to President Henry Morton, of the Stevens Institute to test the various machines and lamps in use, with the view of determining their relative efficiency.

There are three ways of producing electric illumination:—1. By means of the electric arc; 2. By ignited conductors; and, 3. By incandescent gases, the latter of which is hardly of practical utility.

To overcome the difficulties connected with the use of the electric arc, which consist in its unsteadiness, in the wearing away and the combustion of the carbon electrodes, &c., numerous regulators have been devised. "The difficulty with all these," we are told, "is, that however well they may regulate everything else, they cannot regulate the minute accidental variations in the structure of the carbon poles during their consumption." The effect of this is to wear away the poles unequally and to cause the arc to shift its position, so that in the space of a few minutes, the intensity of the light measured in a given direction fluctuated between 400 and 2,000 candle-power. Nevertheless, since the great improvements recently made in the homogeneity of the carbon poles and in the regulating machinery, and since the introduction of reflectors, the electric arc is no longer too unsteady to use for practical purposes.

In the production of the electric light by ignited conductors, the difficulties are that there is a great wastefulness of energy and consequent costliness, and that the conductors are rapidly disintegrated. A current that would furnish an electric arc of 1,000 to 2,000 candle-power would not generate a light of more than 50 to 100 candles when used to ignite a platinum wire, and the platinum so used would soon become brittle and break up.

Higher temperatures were obtained with small rods of carbon placed in exhausted tubes, but they were soon vaporised and disintegrated. At this time Edison had not yet given up platinum. The report concludes that none of the lamps so constructed have proved practically useful as yet, and then goes on to give an historical account of the different inventions of this class for future reference. To show the loss of energy resulting from the division of the current several experiments are described. In one of them a given current produced a light of 65 burners when concentrated on a single lamp; when divided between two lamps, it was reduced to 7½ burners each, among three lamps to 1⅛ burners each, among four to ¾, and among five to ½ burner.

The subject of electromotors, or instruments for producing electric currents, is treated next. To show that the galvanic battery is not economical, the following calculation is made. Weight for weight coal has almost six times the available energy of zinc, and the price of zinc is about 25 times that of coal. Hence to make gas from coal and burn it will be cheaper than to obtain electricity from zinc and turn it into light, unless the loss in the former case is 150 times greater than in the latter.

It follows from this that electric lighting did not become a practical problem until 1831, when Faraday discovered the fact that electricity could be produced from magnetism. Since then numerous magneto-electric machines have been invented, seventeen of which are described and their principles explained. Of these the following were tested in the Physical Laboratory of the Stevens Institute—the Siemens, the Wallace-Farmer, the Brush, the Arnoux-Hochhausen, the Weston, and the Maxim.

The Wallace-Farmer and the Arnoux-Hochhausen machines having been withdrawn after preliminary trials, the remainder were thoroughly tested to find out which was best adapted for use in the Lighthouse Department.

To measure the intensity of the light Sugg's photometer was used in a dark room temporarily fitted up in the Physical Laboratory. At the same time the power employed to drive the machine was measured by means of a transmitting dynanometer designed by Mr. William Kent, a graduate of the Stevens Institute.

In the following table will be found a *résumé* of the results obtained. The first column contains the name of the magneto-electric machine used in each series of experiments; the second contains the kind of self-regulating lamp employed, the word "hand lamp" indicating that the distance between the carbons was regulated by hand; the third column shows the amount of illumination—thus in the first line the figure number 3,297 means 3,297 times the light obtained from one standard candle burning two grains of stearine a minute; the fourth column indicates the horse-power actually used; and the last column, found by dividing the third by the fourth, shows the number of candles obtained per horse-power:—

Machine.	Lamp.	Average candle-power.	Average horse-power.	Average candle-power per horse-power.
Maxim (ordinary type)	Maxim	3,297	5·483	729
Maxim	Hand lamp	3,930	5·585	704
Siemens	Siemens	4,651	4·863	956
Siemens	Siemens	4,548	4·742	959
Weston	Hand lamp	8,585	4·769	1,800
Weston	Maxim	7,787	4·683	1,663
Weston	Siemens	7,262	5·056	1,436
Weston	Weston	6,063	4·552	1,332
Maxim (with magnets of low resistance)	Maxim	7,524	7·400	1,017
Brush	Brush	4,365	2·8467	1,533
Brush	Siemens	3,532	2·9573	1,194

The report concludes with the following words: "In conclusion, your committee would report that they find several of the machines and lamps, with which they have experimented, sufficiently efficient and reliable to warrant further experiment in the nature of a practical test in one of the coast lighthouses."

THE ESSENTIAL NATURE OF ELECTRICITY.

BY J. T. SPRAGUE.

When a wire conveying an electric current is examined, we see no sign of any action, and it is difficult for the uninstructed mind to realise the possibility that this so-called solid and apparently motionless substance is in reality composed of innumerable distinct particles, each going through varied motions. The whole structure of modern science is, however, founded upon such a conception of the composition of solid and rigid substances. The idea may, however, be realised by the aid of an analogy appreciable by all. If we were to observe a large body of soldiers at a great distance, marching on a line of which the extremities were hidden, or upon the circumference of a circle or the sides of a square, all that would be seen would be a definite coloured line, apparently immovable; the individual men composing it would be undistinguishable, and still less perceptible would be the personal motions of each man; yet an army is but a collection of individuals held together by the forces of discipline, by means of which the powers of the units are concentrated and directed. That which distance does for the supposed body of men, minuteness does for the molecules of matter, and the united evidences of science in its domains of chemistry, electricity, heat, &c., render it as clear to the trained mind that the seemingly solid wire is really an assemblage of discrete moving particles held together by various forces, as it would be to any ordinary observer, that a distant army, going through its evolutions, was composed of distinct men, organised by discipline into a complete system.

Even if we examine a liquid conductor conveying a current it is by no means easy to trace out any actual motion in the liquid, nor is there any motion to be discovered bearing any relation to the rapidity of transmission of electricity. In both cases, however, in the solid or the liquid, we know, at all events, that "energy" has been transmitted; produced at one end of the conductor, it is to be found at the other end, and in its passage it has exerted an influence upon the conductor itself which becomes manifest in the form of heat, which heat is now universally admitted to be simply a motion among the molecules of the material conductor, capable of being transferred to all surrounding matter. But while we can trace no change in the conducting matter, where it is continuous and of one substance, we do find evidence of change wherever there is breach of continuity or change of substance. Such evidences are the electromotive force set up in one or other direction when the wire consists of two metals joined together, with the consequent heat or cold produced at the junction; in the sparks produced by burning of the conductor where there is an actual break capable of being crossed; but more especially in the chemical changes set up wherever the electricity enters or leaves a liquid conductor; and it is to these changes that our attention is to be now directed. The changes actually produced are so complicated in nature that their mere description would occupy many pages; but it is not necessary for

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present purposes to enter upon the complete study of electrolysis, interesting and important as that study is. The changes are usually considered to consist of two orders—1. Direct actions of the current upon a single constituent. 2. Secondary or chemical actions of the separated elements upon other substances present. I have endeavoured to trace a law which supersedes this distinction, and connects all the actions together as due to energy, and have formulated this at p. 256 of my "Electricity" as a "General Law of Electrolysis." At the electrodes those substances are set free which absorb, in becoming free, the lowest specific energy. This is, in fact, the converse of the law recently formulated by Berthelot (also long known as a general fact) as the *principle of maximum work*, viz., every chemical change accomplished without the intervention of a foreign energy (heat, electricity, light) tends to the production of the body, or system of bodies, which liberates most heat. But when we seek to study causes or operations, we should look for them in their very simplest form, where they are least disturbed by other agencies, and their actions most easily traced out. The simplest form of electrolysis is that of fused chloride of silver, where there is nothing else present, and the substance breaks up into chlorine and silver. Of these, all the chlorine goes to the positive conductor, or anode, and all the silver to the negative, or cathode. Now let us conceive Fig. 4

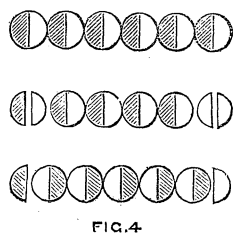

FIG. 4

as representing a line of molecules of Ag Cl, chloride of silver arranged in polar order by the electric action as shown in outline 1. It is evident that there cannot be an action at each electrode which breaks up or pulls a molecule apart; such an action is shown in line 2, and it would result in both the constituent elements appearing at each end of the chain. We are driven to the conclusion that such an action takes place as is shown in line 3, resulting in a complete breaking up and fresh arrangement of all the molecules forming the line of transmission; one element of the terminal molecules separates and becomes free, the other element, surcharged with the energy it is transmitting, breaks up its adjoining molecule, to which it is in fact the electrode, and forms a fresh molecule thus—

$$\overset{\frown}{\underset{\smile}{\text{Ag Cl}}}\ \overset{\frown}{\underset{\smile}{\text{Ag Cl}}}\ \overset{\frown}{\underset{\smile}{\text{Ag Cl}}}\ \overset{\frown}{\underset{\smile}{\text{Ag Cl}}}$$

the upper brackets showing the original order and the lower ones the new arrangement of molecules. I must defer the following out this subject to another time, and will now make a few remarks upon such criticisms as have so far appeared upon the first paper on this subject. As to Mr. FitzGerald, p. 153, I feel sure that it will be found that the difference between us, fundamental as it looks, will prove to be but very slight in reality, and of no consequence as to its results. He says, "it is almost certain that the *modus agendi* of electrical conduction is a rotation of molecules," and I hold that this rotation of molecules is what we measure as quantity and call electricity. I am interested in the addition he has made to my diagram, but it does not satisfy me; it seems to me that what he measures by it is the tension, or pressure in the pipes, not the inductive effect upon all surrounding matter, which is the distinction between the hydraulic and electric currents, while the tension is common to both.

"Ignoramus," p. 175, must allow me to define my own position. I do not accept his statement that "Mr. Sprague agrees with Mr. Preece in choosing the latter horn of the dilemma," viz., that electricity must be either a "form of matter or a form of force, and that there is no other category in which to class it." I say there *is* another category. Electricity is simply a word, and like other words it has a variety of meanings; it practically embodies, links together, and confuses those two things, actions, or properties embodied in E and E^2, which both Mr. FitzGerald and myself seek to distinguish. Therefore, I cannot even accept altogether the modification of a form of energy instead of a form of force, although I have myself often used it. That which we call electricity and measure quantitively cannot be either force or energy. Mr. FitzGerald says it is matter—a special matter; I say it is a function or action of the molecules of all matter. I am heretic enough to doubt if it can be expressed by any combination of M L and T, but think it involves the introduction of a consideration (that is a fundamental quantity) belonging to the field of chemistry. The accepted mathematical formula I consider a mere artificial contrivance, having its uses in calculation, but representing no natural truth. But electricity is a word commonly employed to mean what is really energy, that which is embodied by E^2. This use of the word, general as it is, is logically unsound, and is the source of much of the misconception and confusion which exist. Here, in fact, Mr. Preece fails in the quotation referred to. What he was speaking of was really electric-potential or energy, which is not matter, and also electric quantity, which is not either force or energy; but he, like many others, has confused the two in the one word electricity. The result is not merely a dilemma, but a dilemma both of whose alternatives result in a *reductio ad absurdum*. But then the dilemma itself is a myth. We have to deal with phenomena, their cause, and the mode of action and production. If we call all these by one name, what can result but confusion of mind and mutual misunderstanding? These are convenient enough in theological disputes, where a word commonly accepted often serves to hide very different meanings, but science must be exact and define exactly what is meant by its words. My friend Mr. Phillips, p. 184, seems to be amused by what he calls "my strange duality," motion convertible and inconvertible into work. I thought my argument was clear enough, but I think a familiar illustration can be given, which will carry the idea into every mind, whether it carries my interpretation along with it not. Take a windlass or winch with a rope wound upon it connected to work to be done; we shall now have two distinct forms of motion—1. That of the winch on its axle; 2. That of the rope. The first of these may be counted, and, if each turn represents a given work, such as raising one article from one floor to another, these turns will represent "quantity," that is to say, so many articles lifted; but it is evident that this number or motion on the axle (which is the thing represented in my diagram 2) is in no sense convertible into work. It will be the same whether each single article raised be light or heavy, just as the one "quantity" of electricity acts upon one grain of hydrogen, or 108 of silver; hence also it does not represent either force or energy, nor is it matter. But the other motion (linked though it be to the first) is converted into work; it, in fact, transmits the energy applied to the winch. Its velocity depends upon the relations of the force or energy applied and the work done, that is, the resistance overcome; and the energy represented by this combination of rate of motion and tension on the rope will be as the square of the motion, or, what is the same thing, as the square of the first motion, which is the analogue of C or current in electricity, while the conditions of the second motion are analogous to the $E \times C$, or E^2 or C^2, which measure the energy connected to the electric current, itself measured as C or as $\frac{E}{R}$. But does not Mr. Phillips rather beg the question when he says, "current is *actually current*, in the sense that something analogous to a grain of water is actually transmitted?" That is just what is being debated, and I contend and hope to prove that no *thing* is actually transmitted, but only energy, causing motion. When he says "the binary action is such that metal is projected on one side, and the unknown E on the other," surely this is stating a mere hypothesis as though it were experimental fact. We know that metal or basyle is projected on one side, and we know that an equivalent "cation" is set free on the other side—*that is fact*. That the unknown E is set free is *pure hypothesis*. Of course, there can be no objection to any hypothesis on the mere ground that it is one; in fact, we are all at work upon hypotheses, and must needs be so in the field of atoms and molecules and their motions, seeing that their very existence is a matter of hypothesis; but let us clearly distinguish between a proved fact and a hypothesis, however probable.

ON MAGNETIC CIRCUITS IN DYNAMO AND MAGNETO ELECTRIC MACHINES.*—No. 2.

BY LORD ELPHINSTONE AND CHARLES W. VINCENT, F.R.S.E., F.C.S., F.I.C.

[Communicated by Professor G. G. Stokes, Sec. R.S.
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A large amount of magnetism is retained by the soft iron cores of electro-magnets, when arranged so as to form a complete magnetic circuit; and sparks and other indications of the passage of an electric current can be obtained at the end of the helix wires surrounding those soft iron cores each time the masses of iron are separated and the closed magnetic circuit opened. In order to procure a spark, the breaking of the circuit

* Abstract of a Paper presented to the Royal Society, corrected by the Authors.

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must be effected suddenly, either by a jerk, tilt, or sliding movement.

In the case of the 58lb. magnet described in our former note, the current that is capable of causing a spark, although only momentary in duration, is found to be sufficient in quantity and intensity to magnetize a small electro-magnet, weighing with its coils between 5lb. and 6lb., enabling it to sustain its own weight for any indefinite time when suspended by its armature.

When the armature of the small magnet is placed at the distance of $\frac{1}{8}$ of an inch from its poles, in such a manner as to be free to move, the instant the armature of the large magnet is suddenly tilted or slid off it darts to them, the completion of the circuit of the small magnet being signalled by a smart click. The rupture of one closed magnetic circuit is thus caused to produce another closed magnetic circuit.

But when the interval between armature and magnet, whose circuit it was intended to close, exceeded $\frac{1}{4}$ of an inch, the former was not attracted with sufficient force to overcome the friction of the table upon which it was resting.

The mode of removing the armature from the large magnet appeared to be of no moment, but the time occupied by the removal had much influence upon the amount of magnetic force manifested in the smaller circuit. This was particularly the case if there were an interval, no matter how small, between the armature and the poles of the magnet round which the electric current was sent.

For example, if with an interval of $\frac{1}{16}$ of an inch between the armature and the poles of the small magnet, the armature of the large magnet was slowly slid off, the magnetisation of the small magnet never rose to a sufficient intensity to draw its keeper to itself, whereas, when the sliding took place rapidly, the small armature was strongly attracted as above mentioned.

The largest amount of magnetisation was bestowed upon the small electro-magnet by the interaction, when it was held upright, its poles being completely covered by a closely fitting armature. And it was also found that when thus set up in preparation for the formation of a closed magnetic circuit, the magnetisation was produced by a much slower motion of the large armature than when the small magnet had its circuit partly open. When the circuit was completely closed, if the large armature were twisted off by a slow equable motion, in such a manner that both poles were uncovered at the same time, then the small magnet could be made to sustain not only its own weight (between 5lb. and 6lb.) but an additional 3lb. also.

During the passage of the electric current, obtained by the forcing open of the closed circuit, the fall of magnetism in the large magnet itself is checked, the direction of magnetic polarity remaining unchanged, the current checking or opposing the fall being in the same direction as that from the battery which caused the primary magnetisation. If the ends of the helix wires are not connected together this effect is not obtained.

Electric currents, though of less intensity and quantity, can be produced in the helics of electro-magnets without altogether breaking up the closed magnetic circuits. For instance, with the 58lb. electro-magnet, the circuit being completely closed by its armature, and the helics being connected with a galvanometer, a very slight pull applied to the armature produces a current of electricity giving a considerable deflection of the needle in the same direction as the battery current; and the stronger the pull the greater the deflection of the galvanometer needle up to the point at which the magnet is lifted from the ground, after which no further motion of the needle is produced unless the magnet is subjected to additional strain. Thus hanging a 4lb. weight upon the uplifted magnet produced deflections in the same direction as the pull on the armature, and on removal of the weight produced reverse deflections.

Trying the same set of experiments with a very small electro-magnet, so that we might proceed to absolute rupture of the closed magnetic circuit without danger to the galvanometer, we found that the addition of successive weights to the magnet while hanging suspended by its armature produced successive deflections of the galvanometer, the needle coming to rest at zero after each addition, as in the case of the large magnet.

When the maximum weight which the magnet was capable of sustaining was reached, and a real movement of the armature commenced, the induced current in the helix of the electro-magnet was very greatly increased by the addition of even the smallest weight.

From these experiments it may be inferred that in like manner as the passage of an electric current round a bar of iron produces elongation of the bar, so the elongation of the bar produces in its turn an electric current in the helix, this current tending to strengthen the magnetisation. It would also appear that a magnet is absolutely stronger under tension than when at rest.

On the other hand, pressure on the armature, either continuous or sudden and momentary (a blow for example), causes an electric current in the helices in the opposite direction to original magnetisation, or in other words, against magnetisation, tending thereby to weaken the power of the magnet.

The 58lb. magnet in closed circuit was hung by its armature, and on afterwards connecting its helices with the galvanometer no current could be detected, but on lowering it until it rested with its whole weight on the ground a current in the direction of demagnetisation was produced, giving a deflection of 15°. In the same way a current in the direction of magnetisation was obtained, giving a deflection of 15°, by the application of sufficient strain to lift the magnet off the ground, and this result was invariable. The degree of swing, however, depended upon the rapidity with which the magnet was either raised or lowered.

It may be remarked that whereas any very slight application of force in pulling on the armature was sufficient to cause a current in the helices giving a deflection of 5° to 10° of the galvanometer needle, a great amount of pressure is necessary to produce a similar deflection. A slight pull with the finger and thumb in the one case was equal to the pressure of a hundredweight in the other.

By the momentary removal of the armature, the closed magnetic circuit is broken, and though by its immediate restoration a new closed circuit is formed, nevertheless the tension on the molecules of iron by the magnetic stress is very greatly reduced. Under these conditions a very slight pressure upon the armature produces a great swing of the needle, whilst a pull produces scarcely any effect at all until actual movement of the armature takes place.

If the pressure on the armature is great and continuous, a point is soon reached at which a slight pressure is no longer effective.

The effects produced are somewhat different if pressure is applied unequally. For instance, a weight of 7lb. placed on the armature over the north pole of the 58lb. magnet caused a current in the helices giving a deflection of 20° at the galvanometer. The same weight on the south pole gave the same deflection in the opposite direction. Pressure with the hand produced like swings of the needle proportionate to the force used, and the amount of swing can be easily controlled, and the needle brought to rest by judicious pressure on either pole of the magnet.

If a lateral pressure be applied to one side of the armature between the poles, and the needle swings say 5° on removal of the pressure, a current is produced in the opposite direction, and the reverse swing in place of being 5° will be 8°, and so on in proportion to the amount of force made use of.

None of the above-mentioned effects could be shown with the small magnets under pressure; and it was not found possible to produce a recognisable current without actual movement of the armatures.

Under certain circumstances the attractive force of electro-magnets in closed magnetic circuit is found to increase with lapse of time. For example, a small U-shaped electro-magnet with limbs six inches long, having a core of $\frac{3}{4}$-inch iron, and helices consisting of four layers of No. 16 covered copper wire, when excited by four Bunsen cells, supported as an armature a similar U-shaped iron bar, but without a helix upon it. This latter remained firmly attached after the voltaic current had ceased, but the hanging on to it of an additional weight of 3lb. 6oz. instantly wrenched it away from the electro-magnet, and broke the closed magnetic circuit.

The magnet was then re-excited, the armature being fixed to the electro-magnet by being held in contact with the poles whilst an electric current, of a few seconds' duration, passed through the circulating wire. In place of immediately attempting to add any additional weight, the two iron U's were left hanging face to face, in the form of the link of a chain, for twenty-four hours, at the end of which time the weight of 3lb. 6oz. was hung on and sustained. Forty-eight hours later, an additional weight of 3lb. 10oz. was carefully added, making in all 7lbs. sustained. Twelve hours afterwards 1lb. more was added, bringing up the entire weight to 8lb. beyond that of the armature; this was suffered to remain for five days, when the system was taken to pieces.

On a subsequent occasion the same magnet sustained an entire weight of 10lb beyond that of the U-shaped armature, the weight sustained being reached by beginning with an amount well within the sustaining power of the electro-magnet wire in closed circuit, and increasing it by small additions made with intervening intervals of time varying from twelve hours to several days.

Another and smaller U magnet was likewise experimented on; this weighed with its coils 3lb. 6oz. Its armature was a strip of soft iron completely covering the poles, and having a hook in the centre, to which weights could be easily attached.

This electro-magnet was excited by the passage, for a few seconds, of the current from two one-pint bichromate cells. On

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breaking battery contact, the armature failed to sustain 4lb. The electric current was again sent round the electro-magnet, and the armature was pressed against the poles, being carefully adjusted so as to cover them completely, and, at the same time, to place the hook precisely in the centre, so that the pull should be fair and equal when a weight was hung upon it. By this careful manipulation, on breaking contact with the bichromate cells, the closed magnetic circuit was found capable of sustaining the 4lb. weight.

By successive additions of 2oz. weights, made at intervals of a few minutes, the weight hanging to the armature was raised to 5lb., after which the attempted addition of 2oz. caused the disruption of the system.

The experiment was repeated under similar conditions, but with slightly extended intervals of time between the additions of the 2oz. weights. The magnet in closed circuit was made to hold 4lb., 4¼lb., 4½lb., 4lb. 14oz., 5lb. 2oz., the time taken in all, for the successive additions, being ten minutes. The system was then left for twelve hours, when, by additions of 4oz. at intervals of a few minutes, the weight sustained was increased to 6lb. 4oz. Eleven hours later this was further increased to 7lb. 6oz., and two hours afterwards to 8lb. 2oz.

A still smaller electro-magnet, weighing with its coils 5oz., and having an armature consisting of a very thin slip of soft iron, when excited by one of the bichromate cells, could not be made when in closed circuit to sustain 1½lb. at the moment of breaking the voltaic circuit. It, however, sustained 1lb. with ease. The latter weight was therefore suspended, and the cell wires removed after the closed magnetic circuit was completed. By successive additions of 2oz. weights at short intervals of time (five minutes to ten minutes each), this small magnet could be made to sustain 2lb. 2oz., but the addition of 1oz. beyond this weight at once separated the armature and magnet. It was thought that a longer interval of time should, as in the former instances, enable the magnet to sustain a still greater weight. It was therefore brought into closed circuit, as before, and made to sustain 2lb. 2oz. in the manner just related, and was thus left for twelve hours. Successive additions of 2oz. were then made to the hanging weight until it reached 2lb. 14oz. Twenty-four hours afterwards 4oz. more were added, bringing the entire weight suspended to 50oz.

This small, soft iron magnet which, at the instant the voltaic current was withdrawn, was totally unable to sustain five times its own weight, was thus, by gradual growth of its magnetic force, enabled to hold ten times its own weight.

In the course of these experiments it was remarked that the longer the period the soft iron remained in closed magnetic circuit the more magnetically ductile did its molecules appear to become. An electro-magnet, which had been for a few days in closed circuit, could, after rupture of the circuit, be made to sustain weights in a fresh closed circuit at much shorter intervals of time than if it was magnetised, after being for some time with its poles uncovered. The direction of the battery current with reference to the residual magnetism of the electro-magnets appeared to be of no moment. A magnet which had been left for some time with its poles uncovered had less residual magnetism after a momentary current had passed through its helices, than another magnet which had been in active closed circuit, even if the battery current had, in the latter case, to overcome a considerable amount of residual magnetism.

We found, moreover, that soft iron magnets retain their residual magnetism longer, and are capable of acquiring increased magnetisation much more rapidly after having been bearing weights (thereby keeping the iron in a state of strain), than if they have been left in their normal condition and without bearing any weight at all.

The conditions under which the closed magnetic circuit retains its force are not yet clearly established.

With the 58lb. magnet a succession of gentle taps struck vertically with a wooden mallet upon the centre of the armature, while resting on the magnet in closed circuit, in a very few moments completely dissipated the magnetic force so far as the sustaining power of the magnet was concerned.

Removal of any portion of the weight suspended to the armature of a magnet hung up in closed circuit likewise tends to dissipate the force of the circuit. For example, half an hour after the removal of a weight of 10 lbs., which had been suspended to the armature of a U magnet for twenty-one days, the armature fell off on receiving a slight touch. In another experiment, a U magnet, wnich was capable of sustaining 7 lbs., and which had actually been suspending 4 lbs., was left for two months with the armature on only, the weight having been removed; at the end of that time a very slight shake was sufficient to cause the armature to fall off. Many other examples might be quoted to show that release from strain diminishes the magnetic force of the circuit.

In these experiments, in which the closed magnetic circuits had given way, the soft iron had been in a state of strain from which it had been released by the removal of the suspended weights. But when no weights were hung upon the armature, and the iron had never been in a state of magnetic tension, the closed magnetic circuit, so far from diminishing, increased in force. The 58lb. magnet was excited with a voltaic current so feeble, that although the magnet could be lifted by the armature in closed circuit, yet great care was necessary that the lift should be exactly vertical; and very little force was required to slide the armature off the poles. After the lapse of a month the armature was so firmly held that the utmost exertion of manual force could not stir it by a sliding movement, and the whole magnet could be raised from the ground even if tilted as much as 15° from the perpendicular.

The magnetism of the closed circuit of the 58lb. magnet disappears after repeated up and down movements of either one or both of its helices, provided the ends of the helix wires are connected together either singly in two separate circuits, or together in one continuous circuit. Every up and down movement of either of the helices produces currents in the wires either for or against magnetisation, which currents apparently so disturb the molecules of the iron that the fixity of their original magnetic direction is lost.

In like manner as the movements of the armature, or the increased or diminished tension of the iron, produce currents of electricity in the helix wires surrounding the magnets, so the movements of the helices produce currents of electricity which may either magnetise or demagnetise the iron. With the 58lb. magnet in closed circuit, the two ends of one of the helices being connected to the galvanometer, and the two ends of the other helix being connected with each other, the latter helix is moved towards the armature, a current is produced in the galvanometer helix which shows a fall of magnetisation. On moving the same helix away from the armature, a current is produced in the direction of magnetisation.

In another experiment 30 yards of No. 16 covered copper wire, with its ends connected together, and so coiled that it could be moved freely from pole to pole over the armature, was placed on one limb of the 58lb. magnet, and the closed circuit established. Both helices were then brought into continuous circuit through the galvanometer.

On movement of the coil of wire from south limb to the north limb of the magnet, a current was produced showing an increase of magnetisation. On moving the coil in the opposite direction, *i.e.*, over the north limb pole, and on to the south one, the current is reversed, and is in a direction which would cause demagnetisation.

It appears, therefore, that any interference with the lines of force about a magnetic circuit, means an interference with the magnetic circuit itself, and points to the possibility of building up magnetic force of magnets by the mere movement of wires in these lines of force, though the coils moved need not of necessity be connected with the helices surrounding the magnets.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).

Report of the directors for the half year ending 31st December, 1879, to be presented at the general meeting of shareholders, to be held on Wednesday, the 31st March, 1880. The accounts for the half year ending 31st December, 1879, show a balance to the credit of profit and loss of £4,450 2s. 5d. The traffic receipts for the half year are £1,847 13s. 3d. in excess of those for the preceding half year, and £1,664 5s. 11d. in excess of those for the corresponding period of 1878. The directors deeply regret that, notwithstanding the very favourable result accruing from the increased traffic during the last six months, they are not in a position to recommend the payment of any dividend, either on the preference or ordinary shares. The shareholders may probably remember that a fault of insulation occurred in the Bilbao cable last October. Although it did not stop the traffic, the fault, caused by the small insect known as the "teredo navalis" perforating the gutta percha, would soon have caused a complete interruption, and it was therefore deemed advisable to have it removed at once, more especially as an opportunity presented itself of doing so under favourable circumstances as regards expense by the employment of the ss. Dacia, then on her way home from Algeria. The cost of rectifying this fault, after deduction of value of recovered cable, the shareholders will find in the annexed accounts. On the evening of the 31st December last the Bilbao cable broke down, and, after a series of most difficult operations, its complete restoration was only effected on the 15th inst. The directors cannot ascertain the amount they will have to provide to meet the expenses of these operations until the return of the expedition, but it has been necessary to use such a quantity of new cable, and the time the ship has been occupied has been so long, in consequence of very tempestuous weather, that the board are under the necessity of retaining the whole of the reserve fund and the balance at the credit of profit and loss to meet their liabilities for these repairs. Since the completion of the repairs this cable is in excellent condition, and the Barcelona-Marseilles cable continues in the same perfect electrical state as heretofore.

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MONTEVIDEAN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).

The annual general meeting of the shareholders of the above company was held on the 24th inst., at the offices, King's Arms-yard, Newgate-street, under the presidency of Sir Thomas Gore Browne, K.C.M.G., the chairman of the company.

The SECRETARY having read the notice convening the meeting,

The CHAIRMAN formally moved the adoption of the directors' report for the year ending the 31st December last. It stated that the company's percentage of the gross earnings of the Western and Brazilian Company amounted for the year to £3,040, the December quarter being estimated at £850. The directors had been satisfied that the sum of £432, which the Western and Brazilian Company claimed to deduct as the proportion chargeable to this Company of the cost of carrying messages overland in 1878 whilst portions of their cable were under repair, was a proper claim, and it had been allowed accordingly. After deducting this sum and the dividend declared at the last shareholders' meeting, there remained a balance of £234 to bring forward from last account. It should, however, be explained that the percentage receivable for the last quarter in 1878 was over-estimated in last year's accounts to the extent of £110, so that the actual balance brought into this year's accounts was only £123. After setting aside £500 for redemption of debentures, and providing for all charges and debenture interest accruing during the year, there remained a net balance of £1,229, out of which it was proposed to pay a dividend of 2s. 6d. per share (£1 5s. per cent.), and to carry forward a balance of £190 to next account.

Lieut.-Colonel G. W. MACAULEY seconded the motion, which was carried unanimously.

The CHAIRMAN then moved, and Lieut.-Colonel MACAULEY seconded a resolution declaring the dividend recommended, and the motion was also carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. DARBYSHIRE, the retiring director, Lieut.-Colonel Macauley was re-elected.

Mr. MACKENNON next moved, and Mr. CHAMOT seconded the re-election of the retiring auditor, Mr. Wm. S. Ogle, and the motion was carried unanimously.

On the motion of Mr. MACKENNON, seconded by Mr. DARBYSHIRE, a vote of thanks to the chairman was passed, and the proceedings terminated.

ABSTRACT OF PATENTS.

2321. PRODUCTION AND REGULATION OF ELECTRICITY FOR ILLUMINATION. *J. D. F. Andrews.—Dated 11th June*, 1879. 6*d*.

A dynamo-electric machine is constructed in the following manner:—On the surface of a long cylinder are fixed a number of electro-magnets parallel to its axis, each magnet consisting of a long iron core wound lengthwise with insulated wire. This cylinder revolves between the poles of two stationary magnets, extending radially on each side of the cylinder, the outer ends being connected by iron with each other, so that the two form a complete horseshoe. In order to regulate the quantity of electricity supplied to the lamps, the coils of the machine are wound with several separate parallel wires, each connected through its commutator to a contact plate or spring, which bears against the face of a sliding bar, part of which is of conducting and part of non-conducting material.

2497. TRANSMITTERS FOR TELEPHONES.—*A. Marr. Dated 21st June*, 1879. 6*d*.

The diaphragms are made of wood, and inside and near the centre are attached discs of solid carbon placed close to each other and connected respectively with the opposite poles of a voltaic battery or a magnetic current; the receiving telephone being in the circuit. The outer edges of the diaphragms are joined together by an angular piece of wood, and the space between, about ⅛in.—the carbon discs being about 1-16in. apart—is filled with powdered carbon.

2543. MANUFACTURE OF CARBON CANDLES OR POINTS FOR ELECTRIC LIGHTING, &c., *F. J. de Hamel.—Dated 25th June*, 1879. 4*d*.

This relates to the manufacture of candles, or points, or plates of carbon combined with wire or metal.

2554. PRODUCING MOTIVE POWER FOR THE ROTATION OF MAGNETO MACHINES, &c., *J. B. Rogers.—Dated 25th June*, 1879. 6*d*.

This consists of an apparatus by means of which a rotative motion is produced by a head or column of water furnished by syphon action.

2652. ELECTRIC LAMPS, *C. W. Siemens.—Dated 1st July*, 1879.—*(A communication.)* 6*d*.

This consists in dividing the conductors to and from an electric lamp into two branches, the one including with the lamp circuit a solenoid or electro-magnet coil of low resistance actuating a core or armature connected by a lever to one of the carbon slides, so as to separate the carbons, and the other including in a circuit connecting the conductors externally to the lamp a solenoid or electro-magnet coil of higher resistance actuating a core or armature connected by the said lever to the carbon slide, so as to bring the carbons nearer together, the regulation of the lamp being thus effected by the differential action of the two coils independently of fluctuations in the electrical circuit with which the lamp is connected.

2654. TELEGRAPHIC APPARATUS.—*E. C. Warburton and L. J. Crossley. Dated 1st July*, 1879. 6*d*.

This consists in the use of an artificial magnet meridian.

2744. ELECTRIC LAMPS, *G. Whyte.—Dated 5th July*, 1879. 6*d*

This relates to the construction or combination of the parts of electric lamps with all the movements required, either for revolving disc, or bar electrodes, or carbon points, effected from a single moving core, hollow electric coil magnet, and connecting fittings.

2656. IMMERSING SUBMARINE TELEGRAPHIC CABLES. *A. Blondot and J. Bourdin.—Dated 1st July*, 1879. 6*d*.

The cable is wound with regularity on a drum, to which the movement for unwinding is given by gear, which is capable of varying the speed. At the stern of the vessel is a pair of delivery rollers with a caoutchouc surface, and driven by the shaft of the drum with the aid of two intermediate devices, viz., first, a round strap which passes over the drum and has an independent tightening device; and secondly, a brake analogous to those employed to obtain a regular tension of the thread in a sewing machine.

2674. TELEPHONES.—*S. Pitt. Dated 2nd July*, 1879.—*(A communication)*. —1*s*. 4*d*.

This consists in the use of a switch at each station, constructed and connected so that an earth connection can be established on either side of the telephonic apparatus, according to the direction in which it is desired to communicate without breaking the continuity of the circuit.

2905. GALVANIC BATTERY, *C. H. Carlson.—Dated 16th July*, 1879. 2*d*.

Zinc and copper plates are placed parallel to each other, and separated by paper or felt saturated in a specially exciting salt or basic acid, which, when placed on any part of the body, is caused to produce a gentle current by means of the perspiration of the body.

2962. JOINTS OF PIPES FOR CONTAINING UNDERGROUND TELEGRAPH WIRES.—*A. M. Clark. Dated 21st July*, 1879.—*(A communication.)* —8*d*.

The socket of one length of pipe is for a portion of its length of a size to receive the spigot end of the next length, the remainder of its length being enlarged and formed with a circumferential groove to receive a lead packing.

3001. INSULATED WIRES AND CABLES, &c., *W. Moseley.—Dated 23rd July*, 1879.—*(Not proceeded with.)* 2*d*.

The wire or cable is surrounded with twisted strands of horsehair, and the whole then saturated with melted resin or gum, with a little oil to toughen it. It is then enclosed in a double sheathing of copper, with tin between the double sheath.

TRAFFIC RECEIPTS FOR FEBRUARY, 1880.

COMPANIES.	Feb. 1880.	Feb. 1879.	Increse.	Decrse.
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company.....	—	—	—	—
Cuba Submarine Company.....	3,200 estd.	2,775	425	—
Direct Spanish Telegraph Company	—	—	—	—
Direct United States Telegraph Company ...	—	—	—	—
Eastern Telegraph Company	44,591	37,251	7,340	—
Eastern Extension Telegraph Company	25,190	22,409	2,781	—
Great Northern Telegraph Company	14,160	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company..	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—
West Coast of America Telegraph Company.	—	—	—	—

ADDRESSES.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

PETER BROTHERHOOD, Engineer, 56 and 53, COMPTON-STREET, GOSWELL-ROAD, E.C.
Specialities—Patent 3-Cylinder Engines (Silver Medal, Paris), as used by Siemens, Gramme, and Wilde for driving Electric Machines.

RANSOMES, SIMS, and HEAD, Orwell Works, IPSWICH.
Specialities—Portable and Stationary Engines, fitted with patent governors, as tried in the electric lighting experiments on the Thames Embankment.

ABBOTT and Co., NEWARK-ON-TRENT.
Specialities—The "Standard Size" Vertical Cross Tube Boilers. Illustrated catalogue, giving every detail of a variety of Boilers 2s. 6d., post free.

CARBON ELECTRODES COMPANY. Works: 39, COMMERCIAL-ROAD, EAST.
Specialities—Carbon Rods of all sizes for Electric Lighting. Also, Plates and all other Moulded Carbon Goods. List of prices on application.

M. THEILER & SONS, Telegraph Instrument Manufacturers, 86, CANONBURY-ROAD, N. Works: ALWYNE-LANE, N.
Specialities—Morses, Polarised Relays, Saunders' Curb Keys, Type Printers, Recording Sounders, Duplex Apparatus (Theiler's Patent).

HOOPER'S TELEGRAPH and INDIA RUBBER WORKS, MITCHAM and MILLWALL DOCKS.
Contractors for the Manufacture and Laying of Submarine Telegraph and Torpedo Cables. Manufacturers of Hooper's celebrated Insulated Core. Printed reports on application. Offices: 31, LOMBARD STREET, LONDON, E.C.

THE BRITISH ELECTRIC LIGHT COMPANY (Limited), 41, PARLIAMENT-STREET, WESTMINSTER, and 17, WATER-STREET, LIVERPOOL.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

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SLIP

CHICAGO.—A company is being formed to introduce the electric light system of Mr. C. A. Hussey.

HARTMANN.—Two brothers of Hartmann, the contriver of the Moscow explosion, are in the South Russian Telegraph Service.

PROTECTION TO TELEGRAPH WIRES.—The Prussian Director-General of Telegraphs has requested all schoolmasters within the kingdom to instruct their scholars not to damage the telegraph wires in any way or form.

"SCIENCE FOR ALL."—In the current number of this publication of Messrs. Cassell, Petter, and Galpin, there is an article, by Captain C. King, describing Mance's Heliograph and other forms of "The Sun Telegraph."

"THE MAGNET."—This is the title of a new American paper, fashioned somewhat on the same lines as the *Operator*—that is to say, it practically eschews the scientific and undertakes to cater for the hours of relaxation.

THE ELECTRIC LIGHT ON THE EMBANKMENT.—This light will be continued for another year, the Board of Works having accepted the terms of 2½d. per hour per light. The Board have also granted the Edison Telephone Company permission to lay wires in the subways in Southwark-street and Commercial-road.

THE TELEPHONE.—Application has been made on behalf of Messrs. Elanger to connect all the houses in Berlin to a great central exchange by telephone. Edison's telephone has been put into use between the Pic du Midi and Bagneres. Wet layers of air were found to interfere with its working at first, but the apparatus has been suitably modified.

USE OF THE TELEPHONE AS A GALVANOSCOPE.—In a communication to *La Lumière Electrique*, Lieut. M. des Portes points out that when an interrupted current is transmitted through a Bell telephone the sound produced is under certain conditions stronger when the current is *direct*, or in the same direction as the hypothetical currents in the magnet, than in the contrary case.

USE OF THE TELEPHONE AT THE VOLUNTEER REVIEW ON EASTER MONDAY.—The telephonic communication established between Newmarket Farm and Lord Ranelagh's brigade on Castle Hill worked satisfactorily under the superintendence of Colonel Wiggans, 16th Lancers. The distance spoken over was about a mile, and the appliance was found of considerable service in transmitting orders and giving and receiving intelligence.

THE ELECTRIC LIGHT IN LIGHTHOUSES.—Several lighthouses in France, including those of Baleines and Palmyre, in the department of Charente-Inférieure, and that of Planier, in course of construction near Marseilles, are to be supplied with the electric light. The French lighthouses already furnished with this improvement are three in number, viz., the two of la Hève, near Havre, and that at Gris-Nez, near Boulogne.

TELEGRAPHIC LITIGATION.—The Western Union Telegraph Company recently obtained an injunction restraining the Kansas Pacific Railroad Company from using or retaining its wires. This has been decided in favour of the Western Union by the State Court of Kansas. In the U.S. Court at New Orleans the American Union Telegraph Company has been denied the privilege of building a line along the New Orleans and Mobile Railroad.

A NEW PHASE IN TELEGRAPHIC WARFARE.—The American Union Company, in its attempt to wrestle with the Western Union, has proceeded to acts hitherto unknown in the telegraphic world. It has taken—without your leave—some thousands of miles of railroad line hitherto in the hands of and held by contract obligations by the Western Union. Legal injunctions have been laughed at. The result of all this remains to be seen.

INFLUENCE OF THE FORM OF THE AMATURE UPON MAGNETIC ATTRACTION.—Amongst the results obtained by M. du Moncel in his recent researches upon the conditions which influence the force exerted by electro-magnets is the following:—A cylindrical armature, having the same extent of surface as one of prismatic form, is attracted with much less force than the latter, and the ratio between the forces may be as high as that of the numbers 85 and 44.

VERY CONSIDERATE!—Our erratic French contemporary, *L'Electricité* (March 5th), says:—"We see with pain that certain French scientific journals have noticed and illustrated certain articles on the Birmingham Wire Gauge. Every innovation tending to retard the disappearance of feet, inches, lines, gallons, pounds, &c., will be banished from these columns as unworthy to figure in a serious scientific publication. The best service that we can render to English scientific men is to bury in silence this proof of their ignorance."

THE SAWYER-MANN LIGHT.—On the evening of the 16th W. E. Sawyer gave an exhibition in New York of this electric light. In appearance the lamps much resemble Argand gas burners. There was an upright glass cylinder hermetically sealed, and containing nitrogen, in which was an incandescent pencil of carbon. The novelties are a cement which makes the cylinder perfectly tight, an automatic feeding apparatus for pushing up the carbon pencil as fast as required, and an attachment by which each light can be regulated by itself without in any way affecting the others.

TRANSMITTING LIGHT BY ELECTRICITY.—A patent for the purpose of transmitting scenes to a distance by means of electricity has been applied for at the U.S. Patent Office by Messrs. Connelly Brothers and M'Tighe, patent agents, Pittsburg. The inventors believe that two persons talking by telephone, will also, by their device, be able to see each other, and that a printed or written document can be seen in this way and read off. A single wire is required to transmit a diminutive image which is magnified at the receiving station. Here, if anywhere, seeing is believing!

TELEGRAPHIC CONFERENCE IN AMERICA.—The third aunual meeting of the District Companies in the States and Canada will be held at Baltimore on May 10. Among the subjects announced for discussion are:—"Ideas on the practical working of the telephone as applied to district work, and can it be improved?" "The various ways in which messengers can be used;" "Can our Circular Delivery Exchange be improved, and how?" "Burglar Alarm Improvements;" "Can our general mode of business be improved?" "Can our messenger force be improved?" and various other topics looking to the improvement and increase of business.

THE MORSE ALPHABET IN DANGER.—An American, Mr. C. G. Burke, proposes a telegraphic alphabet founded upon musical notation, viz., a system of lines and spaces. He suggests to have three lines and two spaces, and uses dots and dashes to represent the characters of the ordinary alphabet. The position and the number of the dots or the dashes indicate the equivalent in the Burke vocabulary.

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Although it may seem dangerous to so often condemn the numerous suggestions from our friends across the Atlantic, we must state that such a system as the one proposed would make what is now simple more complex, and hence less useful

Electro-Brassing.—In order to deposit an alloy of uniform composition, M. J. J. Hess employs an anode of cast brass covering the whole interior surface of the depositing tank. Within the latter he introduces a solution composed of two litres of water, 84 grams of bicarbonate of soda, 54 grains of sal ammoniac, and 13 grains of cyanide of potassium. In about an hour, by passing through the solution a current from a battery such as would ordinarily be used for electro-brassing with a tank of given size, using a plate of brass or any other conductor as a cathode, the solution becomes charged with copper and zinc in the proportions furnished by the alloy.

Magneto-Mechanical Sorting Machine.—Breuer and Schumacher have invented a machine for separating the turnings and borings of brass and copper from those of iron and steel. The mixed metals fall on a magnetised cylinder or drum, to which the iron and steel adhere, while the copper and brass fall into a special reservoir below. There are two hollow cylinders rotating in the same direction, so that the iron which escapes from the first cylinder is retained by the second. The surface of the cylinders is formed by flat bands or strips of soft iron alternating with strips of copper, and each of the iron bands is in contact with a row of horse-shoe magnets. The adherent metal is removed by revolving brushes.

Fire-Alarm Telegraphs.—The Board of Fire Commissioners of Cincinnati is in trouble concerning the unsatisfactory working of its fire-alarm telegraph. The Police and Fire-Alarm Telegraph Committee of Councils of Philadelphia report that a restoration of the present system would be useless, and that a radical change is absolutely essential. Appended to their report is a resolution authorising the Superintendent of the Police and Fire-Alarm Telegraph to advertise for proposals for the construction of a perfect system of fire-alarm telegraph, with all the best and latest improvements, covering the entire city with not less than four hundred signal-boxes and not less than thirty-six engine-house gongs.

A New Lecture Lantern.—Mr. Holman, the Actuary of the Franklin Institute, U.S., has constructed a lantern for the oxyhydrogen light which combines a great many advantageous qualities. It may, at a moment's notice, be changed into a vertical lantern for showing precipitations, the action of a magnet on iron filings, electrolysis, &c., on the screen. It can also be converted in a twinkling into a projecting microscopic, and with equal facility it becomes a megascope for projecting the image of solid objects. At a recent course of lectures by Mr. A. E. Outerbridge, jun., of the U.S. Mint, on "Coins and Coinage," enlarged images of rare coins were projected by Mr. Holman's apparatus on the screen with great sharpness and brilliancy, and the lecturer was able to show the cupellation of gold and silver to the audience, an experiment which Mr. Chandler Roberts performed before the Physical Society at its last meeting, as described in our report.

Heating Boilers by Electricity.—Mr. Charles Davis, of Paris, has conceived the bright idea of heating ordinary steam boilers by winding them spirally with platinum wires, and sending through the wires a current of sufficient strength to boil the water. Mr. Davis, however, has omitted to state how much platinum wire he will require, and whether he expects to buy it second-hand; also how he is going to insulate his wire electrically from the boiler, and yet heat the latter; also, how he intends to produce the requisite amount of electricity, and, lastly, at what cost per horse-power he intends to furnish the steam. A great deal may be done by an inventive genius like Mr. Davis, but yet we would recommend that gentleman to try his plan by experiment before he rushes with it to the Patent Office. If he takes the latter course he will, perhaps, land himself in hot water; if he takes the former his hopes may suffer a little from cold water, but he will at least have saved his patent fees.

The Climax of Invention.—The Bridgeport *News* describes an invention, credited to a Bridgeport Yankee, to prevent market men from palming off old eggs for fresh ones. The inventor proposes to arrange a rubber stamp in the nest of every hen, with a movable date. This stamp is arranged with a pad that is saturated in indelible ink. When the hen lays an egg, as is well known, she kicks slightly with her hind leg. An electric disc is arranged so that her foot touches it, and the stamp turns over on the ink pad, and then revolves, stamping the date on the egg. The hen then goes off about her business, the farmer's hired girl removes the egg, and replaces the stamp, which is then ready for another. On each evening, after the hens have retired to their downy roost, the date of the stamp is altered for the next day, and the work goes on. In this way there can be no cheating. You may go to the grocery and ask for fresh eggs, and the grocery man tells you he has some eggs of the vintage of January 29, 1880, for instance. You look at them, and there are the figures, which cannot lie.

A New Micro-telephone.—In order to reinforce the sounds sent by a microphone transmitter and telephone receiver, and also to transmit sounds spoken at some distance from the transmitter, MM. Paul Bert and D'Arsouval have constructed a modified microphone, which merits a short description. The acoustical diaphragm of this microphone is of ebonite, of a thickness altering with the extent of surface, but never less than 0·001 metre, to avoid a nasal twang. The fixed carbon is fastened across this diaphragm, and the movable one which bears on the fixed one is regulated in the following way: The movable carbon is carried by an iron stem balanced on its pivot, so as to move freely and stay in any position. The freedom of the stem can, however, be regulated by a movable magnet, and the pressure between the contacts modified at will. This magnetic adjustment is very superior to that by springs. This microphone is connected through the line to a telephone receiver, either directly or through an induction coil. This microphone gives a remarkably distinct articulation, and it can be easily adjusted by the magnets to transmit sounds spoken in a high key at four or five metres from it. Having thus procured a good transmitter, the authors are now endeavouring to reinforce the received sounds on the telephone.

The Electric Light at the Saint Lazare Railway Station.—The French Railway Company de l'Ouest, following the example of the Companies du Nord and Paris-Lyon-Mediterranée has just made a very interesting trial of two principal systems of electric lighting, and of the new gas-light of the Compagnie Parisienne. The comparative experiments have taken place every evening in the waiting-room of the St. Lazare Station. Each of the three competing lights has to light one-third of the room. 1. The Société Générale d'Electricitié (Jablochkoff's system) uses two candles surrounded by opal glass globes. 2. The Gas Company have fitted up ten improved burners, similar to those in the Rue

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du 4 Septembre. 3. The Société Lontin et Cie. (Lontin, Bertin, et de Mersanne) have four new lamps with a suspension arrangement which allows the height to be regulated. Notwithstanding the loss of light (about 40 per cent.) consequent upon the use of opal glass globes, the four Lontin lamps were found to be amply sufficient to light up the space which was assigned to them. By dispensing with the globes, three lamps would easily attain the same object. The "Compagnie de l'Ouest" is instituting a most careful comparison between the three systems of lighting, and every means will be taken to determine the power required and the expense involved by each of them.

Use of the Electric Light for Navigation during the Night Time.—The Rouen papers give the following details of an experiment in night navigation, which was carried out on the Seine by the aid of the electric light. At half-past eight p.m., the Furet took on board almost all the members of the chamber and of the industrial commission, together with some invited guests. A Gramme dynamo-electric machine, worked by a small Brotherhood motor of from one to one and a-quarter horse-power had previously been placed on board. This served to produce a luminous beam which, by means of a movable parabolic reflector, threw its light to a distance of more than a kilometre upon the path to be taken by the vessel. Starting from the creek of St. Eloi, the Furet, taking the right arm of the river, went up stream successively through the Pierre-Corneille and railway bridges, followed the left bank as far as the Rodet island, and then returned to the starting point. The light worked uninterruptedly during the whole distance, illuminating at a distance every obstacle, searching, so to speak, the river in front of the vessel, and throwing a clear light upon every point that the watch thought worthy of attention. Thanks to this new application of the electric light the security of the navigation of the lower Seine will be greatly enhanced during the night, a result which cannot fail to be of benefit to constantly extending traffic of the part of Rouen.

Edison's Electric Light.—Discussion on this subject still goes on in America, and the Franklin Institute has taken the matter up. A few points brought out in the controversy may not be uninteresting to our readers. In the first place, we learn that Professors Thomson and Houston have just taken out a patent for a dynamo-electric machine. In the second, Edison's cardboard lamp is described by careful eye-witnesses to give a feebler light than a good gas burner. Though it is very bright to look at it does not give a good illumination, owing to a certain *thinness* of the light, due, no doubt, to the small quantity of luminous solid matter contained in the filament of carbon which is heated by the current. The Edison machine generates a current of high electromotive force, and hence the conducting wires to the lamps are no thicker than a horse hair. For the more distant lamps, however, a thicker wire is required. Edison is now experimenting to find what resistance is best for the lamps, and also how to make them durable. For this purpose a record is kept of the life and death of each lamp, and an inquest is held over the body. Fully 22 per cent. of the lamps have failed hitherto, owing to explosion, or collapse, leakage of air through the sealed part of the bulb, and cracking of the inner bulb after lighting, the crack often taking place between the two platinum wires passed through the bulb. The carbon of old lamps has a more metallic lustre than that of new ones. The leakage due to the seal will probably be got over by a second sealing. Edison is able to take out of circuit all lamps but one without destroying the latter, because his generator does not produce more current than that lamp can stand. He gets eight lights per horse-power, but Professor Elihu Thomson pointed out that he could not get more, because the heat energy at present given out by these eight lamps at present nearly equals a horse-power. He estimated the light of each as at best only ten candles, that is eighty candles per horse-power; but by the arc method it is easy to produce 800 candles, or ten times as much light per horse-power.

Application of the Telephone to the Measurement of the Torsion of Driving Shafts and of the Work Done by Machines.—The ingenious device of M. Carlo Resio, described by him in *La Lumière Electrique*, is to fix at equal distances round the shafts, at or near each of its extremities, a number of pallets of soft iron, acting as armatures to two stationary electro-magnets, and moving in equal proximity to the poles of the latter as the shaft revolves. The electro-magnets being circuited through a telephone, so that the currents induced in them tend in opposite directions, no sound is produced by the instrument when the apparatus is properly adjusted and the shaft revolves without torsion. It will be seen, however, that the slightest effect of torsion will disturb the equilibrium by throwing the armatures into different planes, a series of induced currents, which affect the telephone, being then produced. The *acuteness* of the sound emitted by the instrument depends upon the number of armatures and the velocity of rotation; but the *intensity*, it is stated, depends upon the angular displacement of the armatures, or the torsion of the shaft. This may be accurately ascertained by shifting one of the sets of armatures until no sound is produced in the telephone. If we call L the length of the shaft between the two sets of armatures, and d the angular displacement of the latter in circular degrees the torsion x for unit length will be $x = \frac{d}{360}\text{L}$. If x_1 be the torsion of the shaft when the machine does no work, the expression $\frac{x'}{x}$ will be the ratio between the force necessary to overcome friction, &c., and that actually transmitted to the shaft. The force necessary to produce a given torsion may be measured by a dynamometer, having a lever of length H, when one end of the shaft is fixed. If a force of P kilograms produces the torsion ρ on the length of shaft L, the torsion of unit length will be $x = \frac{\rho}{\text{L}}$. If we know the angular velocity and the number n of revolutions of the shaft in unit time, we have all the elements necessary for calculating the work done. For, since the force P, the moment of which is P H, produces a torsion ρ, the force necessary to overcome friction is $\frac{\text{P}\,x_1}{\rho}$; and the force corresponding to the torsion ρ, measured by the telephone by displacing the armatures will be $\frac{\text{P}\,x}{\rho}$. The force P being applied through a lever of length H, the total work transmitted through the shaft will be $\text{P}\,2\,\pi\,\text{H}\,n\,\frac{x}{\rho}$. That absorbed by friction, &c., will be expressed by $\text{P}\,2\,\pi\,\text{H}\,n\,\frac{x_1}{\rho}$; the useful work will be $\text{P}\,2\,\pi\,\text{H}\,n\,\frac{x - x_1}{\rho}$; and, lastly, the ratio of the effective to the total work, or the *duty* of the machine, will be $\frac{x - x_1}{x}$.

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APPARATUS FOR THE TRANSMISSION OF POWER BY ELECTRICITY.

BY G. J. HOPKINSON, F.R.S.

The invention of Mr. Hopkinson, relating to improvements in apparatus for the transmission of power by electricity, has reference to means of reversing the direction of rotation of the armature of a dynamo electric or magneto electric machine when such machine is used for converting an electric current into mechanical power.

He uses instead of a single pair of copper brushes or equivalent devices as heretofore to admit the current to and conduct it from the commutator or collector of the armature two pairs of brushes or equivalent devices, one pair for each direction of rotation may be employed, these brushes being arranged in the following manner:—On opposite sides of the axis of the armature are two pins which are insulated from the frame of the machine and from each other, and are coupled together by means of a link or any other suitable connection, so as to admit of their being turned simultaneously in the same direction. Each pin carries two collecting brushes so placed that when one of the brushes (for example) carried by each pin is in contact with the commutator or collector the armature will be caused to revolve in one direction, and that when the other brush carried by each pin is in contact with the commutator or collector the armature will be caused to revolve in the opposite direction. By the act, therefore, of turning the pins in one direction or the other, so as to bring one or the other of the brushes of each pin into contact with the commutator or collector, the motion of the armature in the required direction will be obtained.

The accompanying drawing illustrates the application to the commutator or collector of a Siemens, Gramme, or other machine; in Figure 1 the brushes touch the collector in points appropriate to one direction of rotation, in Figure 2 in points appropriate to the opposite direction of rotation.

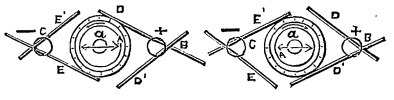

FIG.1 FIG.2

A represents the commutator or collector when the machine is used as a motor, and *a* the axis of the armature, the straight arrow through the centre indicating the direction of the magnetic force of the fixed magnets, and the curved arrow denoting the direction of motion of the armature. On the opposite sides of the axis *a* are two pins B, C, each of which carries two collecting brushes, the brushes carried by the pin B for admitting the current being marked D, D^1, and those carried by the pin C for receiving the current being marked E, E^1. The pins are insulated from the frame of the machine and from each other as before mentioned, and are coupled together by a link or other suitable connection (not shown in my drawings) so as to enable them to be turned simultaneously in the same direction. In Figure 1 the brushes D, E, are represented in contact with the commutator or collector, this position of the brushes being appropriate to the direction of rotation of the armature indicated by the curved arrow in that figure; whilst in Figure 2 the brushes D^1, E^1 are represented in contact with the commutator or collector, this position of the brushes being appropriate to the direction of rotation of the armature indicated by the curved arrow in Figure 2, and which is the opposite of that indicated in Figure 1. By the act, therefore, of turning the pins B, C simultaneously a reversal of the direction of motion of the armature is obtained.

In the drawings the brushes are represented in contact with the commutator at points somewhat behind a plane perpendicular to the direction of magnetic force of the fixed magnets, this being in general the most suitable position for the points of contact. The mode of carrying the brushes is indicated in the drawings in its simplest form, but it is obvious that the brushes may be pressed against the commutator or collector by suitable springs; double brushes may also be used in order to avoid sparks; or in lieu of employing brushes equivalent devices for making contact with the commutator or collector may be used, such, for example, as strips of copper or rollers, as will be well understood.

THE ELECTRIC LIGHT AND ITS PARENTS.

(CONCLUDED.)

The adjourned discussion on recent improvements in electric lighting, which took place at the Society of Telegraph Engineers last Wednesday week, was more interesting and of more practical utility than its opening; and the attendance was quite as large. Some new lamps were shown, and the merits of several others were fully explained. If nothing startlingly novel or important was revealed, a clear gain was conferred on the public at large by the fact being made known that nothing of great importance had been discovered. After a very full statement from various quarters, the general conclusion arrived at was one which Mr. Alexander Siemens, in his reply, summed up in words which, briefly stated, amount to this:—"Electric lighting is very good where it is suitable, and very cheap where the conditions for producing it are favourable." Mr. Siemens proved himself to be no special pleader or partisan, but an advocate who, while doing his duty by his client did not undervalue his opponent's case. Indeed, he concurred in the general conclusion that, for large spaces only, or for limited spaces where machinery already existed, could the electric light be introduced economically.

The hall was lighted on this occasion by two of Mr. Crompton's lamps. We may here mention that the little episode commented upon in our last account between that gentleman and Mr. Alex. Siemens was, we are told, premeditated and to a certain extent prearranged. It came off perhaps prematurely; but it was not rightly chargeable with the offensive construction which we and many persons besides ourselves put upon it at the time. Now, Mr. Siemens had his revenge if he wanted it; for Mr. Crompton's lamps—one of them, at least—did not behave very much better than had the Siemens, and Mr. Crompton felt constrained to apologise for what he was modest enough to call his impertinence in having criticised his rival's exhibition—the moral of all which was that before you can safely expose your lamp to public inspection you must have time to adjust it and adapt it to the special circumstances under which it is to be tried. One of Mr. Crompton's lamps appeared to give great satisfaction on account of the enclosing medium, which shut off the objectionable blue rays. The lamp was, indeed, free from all objection on the score of colour—or the absence of colour—for the light was not only sufficient but agreeable.

Mr. Conrad Cooke supplemented the paper with a *résumé* of the principal improvements made in other quarters, as did also Mr. Shoolbred; and a paper was read, communicated by the agent of the Jablochkoff system in this country, giving all the statistics relating to it, the most valuable item of which was the fact that a great many more lights could, it was found, be fed from one engine than had at first been expected. Many useful improvements have been made in the Werdermann lamp, the particulars of which were described by a representative of the company promoting that system. It appears to combine much of the advantages, in point of steadiness, of incandescent lighting, with the economy of the arc. The Brush machine found a warm advocate in Mr. Ladd, who assured the audience that the Lights now to be seen at the Liverpool-street Station were perfectly steady; and fell short of absolute perfection only because the somewhat sceptical railway company would insist upon burning Gas as well,—a plan which we can quite believe spoils the effect of both. We were assured by one of the speakers that at the British Museum the Siemens light is also perfectly steady; so much so, that somebody had said that they could not tell when daylight ceased and electric light began. This assurance is the more satisfactory as we have heard more than one reader complain of the painful fluctuations in the light. If the experinent at the British Museum is in reality quite satisfactory, all we can say is that the sooner it is tried at the South Kensington Museum the better; for the late hours at that establishment, illuminated by gas, are injurious both to lungs and to pictures: and we sincerely hope that the experiment of a more wholesome system of lighting there on a large scale may not long be delayed.

Mr. Phillips described a method of adjusting the carbons by means of a commutator connected with an *independent* battery which was decidedly novel and which he assured us was in practice free from the apparent drawback of a "blink," the adjustment being so instantaneous that no variarion in the light was perceptible. The proceedings terminated with some common sense observations from the President, Mr. W. H. Preece, who hoped that some better standard than "candle power" would be adopted by the promoters of Electric Lighting, and emphasised our own often expressed conviction that no progress would be made in public estimation until the *space* actually illuminated was made the basis of our calculations.

BROCKIE'S ELECTRIC LAMP.

In this lamp, the principle of regulation by current strength, upon which so many changes have been rung by innumerable inventors with more or less success, is entirely discarded, and Mr. Brockie has made a novel departure in the manipulation of the electric light, which bids fair to render it much more popular than hitherto, as all trouble connected with the regulation of the

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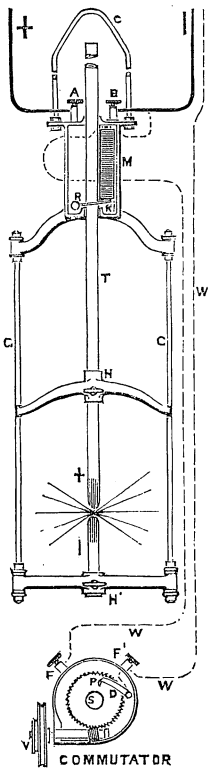
lamps is avoided, and the complicated and expensive mechanism usual in regulators is done away with.

A reference to the figure will show the extreme simplicity of the lamp and its action. The magnet, M, is placed in a separate or branch circuit, W, not in the main circuit as hitherto, and this magnet is cut out momentarily at regular intervals by the commutator shown. This momentary cutting out of the branch and magnet allows the carbons to meet and then to be instantly separated again the correct distance for the development of the arc. This operation is performed by a clutch, R, which allows the carbon holder, T, to fall until the carbons meet, when the magnet is not active, and, in the contrary case, pulls up the holder and thus separates the carbons. Many mechanical devices may be used for this purpose, but the one shown is simple and efficient.

The commutator is driven by the engine or dynamo-machine and timed to break the regulating circuit every minute or other short period, although the intervals may be varied considerably under different circumstances. It might be thought that when the carbons meet, a blink in the light would take place, but the operation is performed so quickly that no flicker is observable, and the light is practically absolutely steady. The increase in the size of the arc during the time the carbons are locked is very small, and may be neglected, but by a trifling addition to the lamp even this may be compensated.



When many lamps are put in circuit, they may with advantage be readjusted at different and equi-distant times in order to keep the circuit resistance more uniform than if all the arcs were re-adjusted simultaneously. This can be done in several ways, either by placing the lamp magnets in separate shunts, and commutating each at different times, or by a modification of the magnet arrangement in the lamps. Only one shunt and one commutator need be used to regulate as many lamps as desired. The re-adjusting magnet in this case is placed in the main circuit, and a second magnet is used to short circuit it when the commutator cuts out the branch circuit as before explained. A small wheel is partially rotated at each impulse of the shunt magnet, and prevents the short-circuiting of the main magnet, except at a definite point or points in its revolution, so that by setting the wheels in the various lamps at different points the lamp will be regulated at different times, although all the shunt magnets are operating simultaneously.

Messrs. Johnson and Phillips, the manufacturers, inform us that the working of this new lamp is highly satisfactory and no trouble has been experienced in keeping them alight, even when the engine speed was varied 50 per cent. above or below its normal rate. The lamps have also been left in the charge of men who were intentionally not instructed in the management of the lamp, so confident were they that no skilled supervision was necessary. The lamps are much cheaper than any in the market, and it is anticipated that the extreme simplicity of their construction, together with the certainty of their action, must secure for them a ready adoption wherever the electric light is suitable.

Mr. Brockie has several modifications of his invention which we may have occasion to describe in a future number. One of the most important of these is a double-carbon lamp which will burn practically continuously.

THE BERLIN ELECTRICAL SOCIETY.

At the meeting of the Berlin Electro-Technical Society, on the 24th ult., when Dr. Stephen, the Postmaster-General of the German Empire, was unanimously elected the first honorary president, Dr. Werner Siemens stated that there were already opened for the public service under the telegraphic department of the German Post Office nearly 1,000 telephone offices. Dr. Siemens also pointed out the extensive system of underground telegraph lines which now connect the principal cities of Germany, and which are to be much further extended in the course of the present year. It was mentioned that the society, which was only started in January, already numbers over 1,000 members. The main business of the evening was the reading of a paper on the "Division of the Electric Light," by Herr von Hefner Alteneck, who is well known for his own inventions and improvements in connection with electricity.

Herr Von Hefner Alteneck said that the electric light depended on a fact, that it heats the conductor through which it passes, and which, in case of sufficient resistance, it is capable of rendering white hot. This quality has been applied directly to the purposes of illumination. The electric light in the narrower sense of the term is based on a further and most peculiar quality of the current, that is, the formation of the so-called arc within a certain limited break or division in the circuit of the current. The electric light arc shows certain very surprising peculiarities that are not very advantageous, so far as concerns its application to illuminating purposes, peculiarities involved in the proportions between its illuminating power, the distance at which it is extinguished, and the power requisite for producing the current. As yet these proportions have not all been ascertained with exactitude. In the construction of new machines for producing the current we are, therefore, compelled to depend on personal experience.

The usual production of electric currents by means of batteries is very disadvantageous, considering the intensity or high strength of the current required for the electric light. Magneto or dynamo-electric machines worked by steam engines or other motors are generally employed.

The first machine of this kind was that introduced in Paris in 1861 by the Compagnié d'Alliance. Messrs. Wilde, Pacinotti, Gramme, and Siemens and Halske have done good service in the invention and construction of such machines. In the development of these appliances an important step was made, when, in 1867, Dr. Werner Siemens made public the so-called dynamo-electric principle. By this the steel magnets were banished from the machine, and the production of the electro-magnets could then be effected by the current produced by the machine itself. While the magneto-electric machines are able to produce currents of alternating direction, the dynamo-electric machines only generate currents of one uniform direction. Both kinds of currents are in themselves very well adapted to produce light, only upon the application of currents of one uniform direction the two carbon sticks burn away at different rates of speed.

With the improvement of the machines producing the currents, the perfecting of the electric lamps went on *pari passu*, these lamps being apparatus for regulating the distance of the carbons in spite of their combustion. Messrs. Duboscq, Foucault, Serrin, Jaspar, Siemens and Halske and others have contributed to the advancement of this department of the art, Messrs. Siemens and Halske having, among other things, brought into operation two different systems. With the machines above referred to single lights could be produced of almost unlimited power, for instance, up to the strength of 40,000 normal candles, but the insertion of several such lamps in the circuit of a current with a view to produce several small lights, in other words the division of the electric light, was impossible from the nature of the case. M. P. Jablockkoff, in Russia, therefore, dispensed with the regulators altogether, and introduced the "Electric Candle." This consists of two thin parallel carbon sticks with a non-conducting material like gypsum placed between them. A small bit of carbon placed on the upper end of the taper brings about the lighting of the electric arc. The bit of carbon is consumed, and the carbon sticks and the intervening material then burn away in common, just like a taper of wax or stearine. Only alternating currents can be employed, and accordingly, at first, the old Alliance machine was taken for the production of the current. Soon the firms of Messrs. Gramme and of Siemens and Halske produced some new alternating current machines, which were exceedingly effective, and were founded on an entirely different principle. A serious imperfection is the great uncertainty of this light, as the carbons go out very readily, and do not light again, thereby causing the extinction of all the other lights in the same circuit, owing to the interruption of the current.

In the meantime Messrs. Siemens and Halske have succeeded in dividing the electric light by means of regulators; and the value of their improvement has been practically proved by the successful employment of their system in numerous establishments.

Divided light in general, like small lights produced by separate machines, has the apparent disadvantage that, in proportion to the aggregate strength of the light a greater amount of force or power is requisite to produce the current. The fact, however, that the intensity of the light decreases with the square of the distance, and that the illumination is dependent on the angle of inclination of the falling rays, makes it appear that it is advantageous to employ separate small lights even in large places or halls, particularly if they are not of any great height. Street lighting with separate electric lights is impracticable. The cost of working the differential lamps is at any rate not so high that it would form an insuperable obstacle to their adoption, and when employed in large halls or spaces electric lighting could be produced considerably cheaper than illumination by gas.

In conclusion, Herr Von Hefner referred to Edison's efforts in connection with the electric glowing light. He said that even if the American's labours came to a practical result—a thing which was by no means certain, judging by what had been made known on the subject—they could not by any means supersede the results which had already been accomplished, but would simply supplement them, and if they did come to anything, they would, of course, be welcomed by all electricians.

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WHAT SHALL WE CALL IT?

"What's in a name?" cried the immortal bard through the sweet lips of Juliet, and the phrase has been bandied about in common speech ever since. "What's in a name? a rose by any other name would smell as sweet." Most true, and yet people cannot help feeling that there is something in a name. Else why does the happy father of a first-born child con over lists of prenames appended to dictionaries, or catch at chance names overheard in talk, or stumbled on in newspapers, with something of the secret pleasure of a gold miner hunting for nuggets. Why did Dickens note down hundreds of names for the probable characters of unwritten novels? Why does the discoverer of a new phenomenon, or the inventor of a new instrument, pry for hours into classical dictionaries which he had never opened in his life before, in order to get the apposite roots for the new term with which he is going to endow science? Why, even the enlightened authors of a new shaving soap, or a pristine ginger-beer, are much exercised in spirit to concoct a taking appellation for their wares, and are eminently alive to the virtues of an appropriate name.

It is no wonder, then, that so august a body as the Society of Telegraph Engineers is in some perplexity over the question what its future title shall be. It is undergoing the birth-pangs of a new name.

Here the problem is not simply by what title the society shall be called in the first place, but how to alter the original and existing title so as to meet the exigencies of the society in the present and the future. It is felt that the existing title is not comprehensive enough to indicate the full scope of the society, viz., "the advancement of *electrical* and telegraphic science," and that the society in consequence fails to secure the support not only of many of that large and increasing body of electricians who, although not telegraph engineers, are professionally connected with other practical applications of electricity, but also of those who pursue the subject from a pure love of science. We quote from the circular which has been sent round to all the members of the society.

In this condition of affairs the council of the society, therefore, recommend that the title should be changed to "The Society of Telegraph Engineers and Electricians," and, being desirous of "giving every member and associate the opportunity of expressing approval or disapproval of the proposed change before submitting the matter formally to a general meeting in November next," they have sent out a circular to all the members in order to get "the views" of these gentlemen on the subject. To provide for the suitable expression of these "views" the prudent council have left a blank space in the circular for the insertion of the word *not*, in the event of any one dissenting from the proposal.

Now, it cannot be said that a mere alternative of Aye or No is a very liberal latitude for any man to state his views in, and we think it is to be regretted that the council have not taken the members still more into their confidence. The act has a smack of the official tyranny which is so interesting and delightfully audacious so long as it is confined to Russian bureaux and Afghan war correspondence. The council of the society affect an air of open confidence and fellowship with the members, and at the same time they plainly show that they do not wish any interference with their determinations. They say, in fact, to the members, We propose to alter the title of our body, and should like your ideas on the whole matter, which being interpreted means, Will you be called So and So or not. There is visible in such conduct a faint tendency to ignore the members of the society, as so many dumb serfs, whose only function is to provide the funds which keep the corporation together, and clap their hands when any shining luminary of the official bench arises to deliver himself of his superior light.

In such a case the members of the society cannot do better than express their views on the subject in question on the margin of the circular, those who care to do so, and luckily there is some margin available for that purpose, though, to tell the truth, not much.

The change of name of the society is really an important matter, and the council have done well to ask the opinion of the members about it. Where they have erred (perhaps unwittingly) is in not giving them greater freedom in stating that opinion. An opinion restricted as they would restrict it is next to no opinion at all. The circular should have presented a choice of several names, all the eligible names which members of the council suggested, and the member should have been asked to signify the one he preferred, or, failing those mentioned, to suggest another. This, unluckily, has not been done, and it therefore remains for the members to state their "views" in their own way.

The title recommended does not seem to us to be a very felicitious one. In the first place it puts the cart before the horse. The aim of the society is avowedly the advancement of "*electrical* and telegraphic science." Here *electrical* science is justly placed before the practical application of it,

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known as telegraphy. Why, then, make the title "The Society of Telegraph Engineers and *Electricians?*" The professional bias of telegraph engineers in council should not be allowed to settle this question. It should be the general welfare of the society, its true scope, and the expediency of the times which should do so. "The Society of Electricians and Telegraph Engineers" is the proper title for the society, if the words "telegraph engineers" are to be retained. The science of electricity, both theoretical and applied, is now so wide, and promises to extend so much in the immediate future, that the term "electricians" is only in its just position in front of "telegraph engineers." Telegraph engineering was once the sole important application of electricity, but it is so no longer, and it will become still less so in a few years. In choosing the final name of a society whose future is so full of promise, we must be careful to take that future into account. The word "electrician" is inclusive of all possible electrical work, and besides it is incorporated with the language of the people, and identified by them with names illustrious in the domain of electricity and telegraphy. In itself it is quite sufficient for the purpose, and the "Society of Electricians" is a short and ample title, but for the sake of a distinction and so forth, the words "and Telegraph Engineers" may very well be retained.

ON A NEW STANDARD OF LIGHT.

BY LOUIS SCHWENDLER.

No exact measurement of any quantity, even with the most accurate and sensitive test methods available, can reasonably be expected unless the standard by which the unknown quantity is to be gauged is perfectly *constant* in itself; or, if nature does not permit of such a desirable state of things, the causes to which the variation of the standard are due, should be known, and in addition also their quantitative effect on the standard, in order to be able to introduce a correction whenever accuracy of measurement should permit and circumstances necessitate it.

This requirement for a standard necessarily entails on the one hand a knowledge of the relations which exist between the standard and the causes of its variation, and on the other hand the possibility of an accurate and independent measurement of these causes.

Further, having no constant standard, it is impossible to produce two quantities of the same kind bearing a fixed and known ratio to each other. Consequently, no idea can be formed of the accuracy of the test method adopted, and if such is impossible we are also unable to improve the test method in itself, *i.e.*, with respect both to accuracy and sensitiveness.

The inconstancy of a standard acts, therefore, perniciously in two directions: it prevents us from being able to execute accurate measurements even with the most accurate and sensitive test-methods, supposing such are available, and, further, leaves us in that deplorable condition of not being able to improve the test-method although we may be convinced that the method of testing requires such improvement.

It may be safely asserted that in any of the branches of the physical sciences where constant standards do not exist, the progress in accurate knowledge of nature must be slow, if not impossible.

This train of thought will, I think, invariably beset the physicist who endeavours to make photometric measurements.

Recent experiments on the value of the electric light as compared with the ordinary means of illumination,* called my attention forcibly to this point.

Old Standards for Light Measurements.—Up to the present in England the *Standard Candle*† has been adopted as the standard of light, the unit of light being defined as that light which the said candle emits when burning steadily at a certain definite rate. In France the *Carcel burner* (Bec Carcel) has been introduced as the standard of light, the unit of light in this case being defined as that light which emanates from a good moderator lamp burning pure colza oil at a given definite rate. The ratio of these two arbitrary units is given by several authorities very differently, the mean value being about:—

10 Standard candles = 1 Carcel burner.

These two standards of light, although answering, perhaps, certain practical requirements, are by their nature ill-adapted to form the units of light intensities. A good and trustworthy standard should possess absolute constancy, or, if not, should afford the possibility of application of a correction for the variation, and, moreover, should be capable of accurate reproduction. These qualifications are certainly not possessed by the standards at present in use.

A candle of whatever compound and size will partake of something of the nature of a complex body, an accurate reproduction of which must always be a matter of great difficulty. Exactly the same holds good for the Carcel burner.

Further, the amount of light these standards produce depends to a very considerable extent on external influences, which do not allow of easy control or measurement, and which, therefore, cause variations in the standard light for which it becomes impossible to introduce a correction. For instance, the rate and regularity with which a candle burns and the amount of light it gives, depend, in addition to the material of which the candle consists, on the ready and regular access of oxygen. In a closed up place, like the box of a photometer, if the draught is not well regulated or the supply of fresh air not quite constant, it can be easily observed that the very same candle may emit light at different times varying as much as 50 per cent. Another difficulty is introduced by the variation of the length of the wick, and of the candle itself, by which the standard light necessarily alters its position in the photometer and, consequently, its quantitative effect on a given point. These difficulties might be overcome to a certain extent by mecanical means, as, for instance, by cutting the wick automatically within equal and short intervals of time, and by placing the candle in a closely fitting metal-tube, against the top rim of which a spring presses the burning candle, in fact a similar construction to that used for carriage candles. But, to say the least, all such arrangements are cumbersome. Without going into further details with reference to the Carcel burner it may be said that the disadvantages of this standard are at least equally great. In fact it appeared to me that the production of a standard light by combustion is not the right method; the flame resembles too much organic life, with its complex and incessantly varying nature. Gauging mechanical force by the power a particular horse of a certain breed is able to exert can scarcely be called a less scientific standard than the combustion standard for measuring light. Under these circumstances I thought it best to leave the old track, and produce the standard of light *by the heating effect a constant current has in passing through a conductor of given mass and dimensions.**

New Standard of Light.—Several platinum photometric standards were made and tried. If the current passing through the platinum was kept constant the light produced was also constant, and for the same current and the same platinum standard the light was always of the same intensity, under whatever other circumstances the experiments were conducted.

Platinum evidently is the best metal which can be chosen, for it does not change in contact with oxygen; it can be procured very pure, and its melting point is high enough to allow an intense light.

It is probable that at a high temperature platinum becomes volatilised, but this process can only be exceedingly slow, and therefore the light produced by a standard cannot alter perceptibly in time. To make the light constant from the moment the current passes, *i.e.*, to establish dynamic equilibrium between the heat produced and the heat lost per unit of time, it is necessary to make the arrangement in such a manner that the electric resistance offered by the standard is only in the piece of

* These experiments I had to institute on behalf of the board of directors of the East Indian Railway Company, under orders of the Secretary of State for India, to inquire into the feasibility and practicability of lighting up Indian railway stations by the electric light.

† The Metropolitan Gas Act 1860 (23 and 24 Vict. cap. 125, sec XXV.) defines the standard candle as:—

"Sperm candles of 6 to the pound each burning 120 grains an hour." I have tried the standard candles as made by two different manufacturers, Messrs. Field and Co. and Mr. Sugg. These candles are sold as six to the pound, and consume according to my own experiments about 8·26 Gm per hour when placed in a large room and direct draughts excluded.

* The idea of using the light produced by a conductor through which a strong current passes as the unit of light, appeared to me so natural and simple, that I could scarcely understand why it had not been proposed and acted upon before.

I could, however, find nothing on the subject anywhere, until lately my attention was called to a small pamphlet, written by Zöllner in 1859, in which the same idea occurs:—

In the preface to his Inaugural Dissertation, Zöllner says:—

"andererseits aber auch zu zeigen, dass ein galvanisch glühender Platindraht von den bis jetzt bekannten Lichtquellen zur Aufstellung einer photometrischen Einheit, trotz mancher practischer Schwierigkeiten, vielleicht dennoch das geeignetste Mittel sei."

I have since learnt that Dr. Draper, as early as 1844, proposed a "unit lamp" consisting of a platinum strip heated by an electric current.

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platinum intended to be made hot by the current, and not in the other parts of the circuit.

For this reason I find it best to cut the piece of platinum out of a platinum sheet.

Figure 1, Plate VIII., gives the form in actual size. The two ears, left white in the drawing, may then conveniently form the electrodes between the leading wires and the piece of U-shaped platinum which has to produce the light. As the U-shaped portion is left in its natural connection with the ears, the contact takes place over a large surface, and therefore the contact resistance must be small. This special form, if the dimensions are defined as well as the weight of the platinum sheet out of which it is cut, can be easily reproduced anywhere. Further, it is required to exclude the draught from the heated platinum. This is best done by putting on a cover of thin white glass. One half of it is left white, the other half is blackened on the inside. This precaution is required in order to insure that light emanating from one side only of the platinum is used in the photometer.

Otherwise light from the back part of the heated platinum would be reflected into the photometer. This part is unknown and could, therefore, not be taken into account when measuring the light emanating from one side of another light. In fact, to be able to form right conclusions from photometric measurements it is necessary to arrange the experiment in such a manner that either the two lights under comparison throw the same fraction of the total light into the photometer, or, if this is impossible, to ascertain this proportion accurately.

The platinum standard light (PSL), described before, we will call in future A. Sending a current of 6·15 webers through it (15° deflection on my large tangent galvanometer, for which the constant = 2.296 C. G. S.), the PSL (A) produces a light equal to 0.69 Sugg's candle, or,

1 Sugg's candle = 1.44 PSL (A) with 6.15 webers.

Hence, if this particular light were adopted as the unit, we might define it as follows :—

6.15 webers passing through a piece of platinum 2 mm. broad, 36.28 mm. long and 0.017 mm. thick, weighing 0.0264 Gm., having a calculated resistance = 0.109 S. U., and a measured resistance = 0.143 S. U. at 66° F. gives the unit for light intensity.*

Photometric Measurements. Having now a constant light it became possible to measure the variations of light which the combustion standards invariably show.

For instance, one of Sugg's candles was compared with the P. S. L. (A) with the result shown in the following table :—

Distance in Millimetres.		Remarks.
P. S. L. (A) with 6.15 webers.	Sugg's candle.	
These readings were taken in about five minutes. 100 mm.	117 mm.	The P. S. L. (A) was kept at the same position = 100 mm.
	120	
	112	
	110	
	120	Sugg's candle was moved in order to get the light equal.
	120	
	120	
	120	
	126	The variations observed were actually in the candle and not in the platinum standard, as the eye could easily discern.
	128	
	117	
	120	
	123	
	127	

This gives an average :—

1 Sugg's candle = 1.44 P. S. L. (A) with 6.15 webers.

$\frac{\text{Max :}}{\text{Min :}} = \frac{1.64}{1.21}$, or total variation of the candle about 30 per cent. from the average in the very short interval of time of about five minutes. This needs no further comment. Some additional experiments were made in order to ascertain the variation of the light of a standard candle.

The P. S. L. (B)* with a current = 5.9 webers was used as unit.

1st candle, 7 readings in 10 minutes

mean = 1.08 P. S. L. (B)

$\frac{\text{max :}}{\text{min :}} = \frac{1.19}{1.00}$ or total variation = 17.6 per cent.

The maximum was obtained directly after having opened the photometer when fresh air entered.

2nd candle, 10 reading in 14 minutes.

mean = 1.07 P. S. L. (B)

$\frac{\text{max :}}{\text{min :}} = \frac{1.32}{0.69}$ or total variation = 59 per cent.

The minimum was obtained directly after freshly lighting the candle.

3rd candle, 12 readings in 24 minutes

mean = 1.07 P. S. L. (B)

$\frac{\text{max :}}{\text{min :}} = \frac{1.30}{0.81}$ or total variation = 46 per cent.

The lowest reading was obtained shortly after lighting the candle.

4th candle, 14 readings in 22 minutes

mean = 0.94 P. S. L. (B)

$\frac{\text{max :}}{\text{min :}} = \frac{1.26}{0.58}$ or total variation = 72 per cent.

The lowest reading cannot be accounted for.

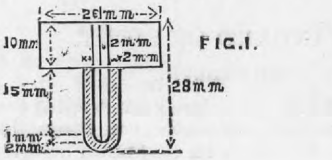


FIG.1.

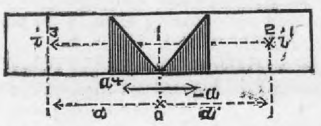


FIG.2

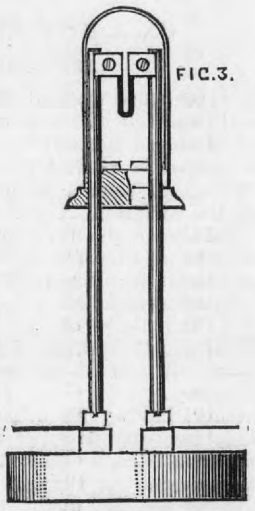


FIG.3.

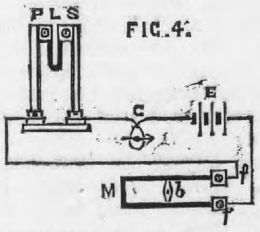
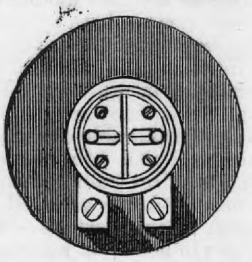


FIG.4.



Two new platinum light standards of the same form and size as the P. L. S. (A), described before, were placed in circuit of 8 Grove's cells, connected up successively, and with a mercury rheostat in circuit to keep the needle of the tangent galvanometer at a constant deflection.

These two new P. L. S., called II. and III., were placed in the photometer to compare their lights, and by it test the accuracy of the photometer readings and other influences to be named further on. (See Fig. 2, Plate VIII.)

$$d + d' = D = 250\text{mm. (constant).}$$

Light i produced by P. L. S. (III.), Light i^1 produced by P. L. S. (II.), the balance between the two lights being obtained by moving the prisms within that fixed distance. A piece of red glass was used for taking the readings.

* In order to show that a platinum light standard can easily be reproduced, I will give here some actual measurements :—

The platinum sheet out of which the P. S. L. (A) was cut weighed 0.0864 Gm. per square centimetre. From this the weight of the part which becomes hot, calculated, gives 0.0264 Gm. The resistance of the standard, measured at 66° F., gave 0.143 S. U., including contact resistances.

Now, another piece of Platinum sheet 26 × 28mm. was found to weigh 0.265 Gm. The piece cut off which actually becomes hot = 0.026 Gm., which agrees within 0.0004 Gm. with the weight found by calculation for the P. S. L. (A) actually used.

Taking the specific resistance of Mercury = 96190
of Platinum annealed = 9158 } at 0° C.

the calculated resistance of the Platinum which becomes hot = 0.109 } S. U. at
Measured resistance, including contact resistance = 0.143 } 66° F.
or contact resistance probably = 0.034 S.U.

It is therefore much more accurate to define the P. S. L. by weight than by resistance.

* This platinum standard (B) was the first made, and has a different form from the other (A) described. Dimensions and weight cannot be accurately given now.

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In the following table the results are given :—

No. of Experiment.	P. L. S. II producing i^1 d^1mm from Prism.	P. L. S. III producing i d mm from Prism.	Deflection on Tangent Galvanometer.	$\frac{i^1}{i}$	Remarks and Particulars.
1	100	150	18·8		
	100	150	18·8		Both lights having glass covers, but glasses were quite clear.
	100	150	18·8		
	100	150	18·8		
	100	150	18·8		
	99	151			
	100	150			
1	99.86	150·14	18·8	0·44	
2	103	147	18·8		
	102	148	18·8		A clear glass cover on No. III; no glass cover on No. II.
	102	148			
	103	147			
	102	148			
2	102·4	147·6	18·8	0·48	
3	98	152	18·8		
	97	153	18·8		A clear glass cover on No. II; no glass cover on No. III.
	98	152	18·8		
	98	152			
	98	152			
	99	151			
	98	152			
3	98	152	18·8	0·42	
4	98	152	18·8		
	98	152	18·8		A glass cover on No. III, the back of it covered inside with black paper; a clear glass on No. II.
	99	151	18·8		
	100	150	18·8		
	100	150			
	98	152			
4	98·83	151·17	18·8	0·43	
5	101	149	18·8		
	101	149	18·8		Both lights covered up with glass covers, each glass cover having inside a black paper.
	102	148	18·8		
	101	149			
	101	149			
5	101·2	148·8	18·8	0·46	
6	103	147	21·0		
	101	149	21·0		Currrent increased by decreasing the resistance of the Mercury Rheostat, but kept constant at 21°.
	101	149	21·0		
	101	149	21·0		
	101	149	21·0		
	101	149			Clear glass again on both like experiment No. 1.
6	101·3	148·7	21·0	0·46	
7	104	146	21		
	103	147	21		Clear glass cover on No. III.
	102	148	21		No glass cover on No. II.
	102	148	21		
	102	148	21		
			21		
7	102·6	147·4	21	0·48	
8	101	149	21		
	100	150	21		Clear glass cover on No. II.
	100	150	21		
	99	151	21		No glass cover on No. III.
	100	150			
	100	150			
	100	150			
8	100	150	21	0·44	
9	101	149	21		
	101	149	21		Both the clear glass covers on.
	101	149	21		
9	101	149	21	0·46	

The deflection 18·8° represents a current = 7·82 webers.
The deflection 21·0 represents a current = 8·81 webers.

From these results the following conclusions can be drawn :— The thin glass covers, as was to be expected, absorb a measurable quantity of light. Compare the results of experiments Nos. 1, 2, and 3, and of 6, 7, 8 and 9.

Covering the glass covers inside with black paper to avoid back-reflection, appears to weaken the light, as was to be expected. Compare the results of experiments Nos. 1, 4 and 5.

The ration $\frac{i^1}{i}$ of the two lights is independent of the strength of the current, which it ought to be.

These results, although showing nothing extraordinary, *i.e.*, what could not have been foretold without making the experiments, are nevertheless valuable, since they prove that in the first instance thin glass covers take away very little light, and that back-reflection is also very little; but small as these influences are, they have been unerringly measured by the photometer, showing this instrument to be very accurate and the eye quite trustworthy. That the light i produced by P. L. S. III. was so much more intense than i^1 produced by P. L. S. II., is due to the fact that the platinum sheet out of which No. II. was cut was much thicker than the other.

Detailed description of the Standard and the method of using it.

Fig. 3, Plate VIII., gives the construction of the platinum standard in half its natural size. I need not give further explanation on this point as everything will be readily understood from the drawing.

Fig. 4 shows the diagram of the connections.

P.L.S. is the standard—

G a current indicator, or better, current measurer. The deflecting ring must consist of a few convolutions of thick copper wire of no perceptible resistance. The small magnet needle is best to be pivoted, carrying a long aluminium index.

E is the battery, consisting of a few elements of high E. M. F. and low internal resistance connected up successively. Grove's, Bunsen's, or large Daniell's cells will answer well for the purpose.

(1) is a stopper by which the circuit can be cenveniently opened or closed.

M is a mercury rheostat of about one unit resistance. A groove of about 1 mm. section and 1 metre total length is cut into hard wood (not ebonite, as mercury does not run well in ebonite). The hard wooden board is supported by three levelling screws.

Further, the mercury is in perfect metallic contact with two iron terminals, *f f*. These terminals are not to be fixed to the board. They are simply placed into the mercury, which fills small reservoirs at each end of the mercury thread.

The resistance of the mercury rheostat can be easily altered by moving the bridge *b* along the two parallel mercury grooves. If the bridge is taken out, the total resistance of the rheostat is in circuit.

If the bridge, *b*, is close to the two terminals, *f f*, the resistance of the rheostat is nil.

This range of resistance with about 6 to 10 volts will prove sufficient to make the current strong enough and to keep it constant for many hours, especially if the precaution is taken to open the circuit when no light is required. The bridge, *b*, consists of a strip of copper at least 2cm. broad and 1 mm. thick. The knife edges which dip into the mercury are amalgamated.

The current measurer, G, has been gauged by comparison with a standard tangent galvanometer; so that the currents indicated by certain deflections of the needle are correctly known in absolute measure.

Whenever a photometric measurement is made the current is adjusted to its defined strength, *i.e.*, the given known deflection is procured by moving the copper bridge, *b*.

If the instrument G is will constructed, this adjustment of current strength can be executed as accurately as weight measurement by a chemical balance.

Correction of the Standard.

Although with the above arrangement it will be always possible to keep the current constant and up to its defined amount, it might nevertheless happen under particular circumstances that the current producing the light has been rendered different from the current for which the standard has been defined.

In this case the following correction can be applied :—

$$\iota = \frac{1}{(1+a)\left(\frac{c}{\gamma}\right)^2 - a}$$

where c is the current for which the intensity of the light has been defined as unity.

γ the actually observed current, and a the co-efficient for platinum which gives the percentage variation of resistance for high temp. 1,500°-2,000° F. for 1° Celsius.

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This correction has been developed under the supposition that the light produced in the given piece of platinum is proportional to the work done by the current through the resistance of the platinum, and that, further, temperature and light are proportional. These suppositions are almost correct for small variations of the current.

In conclusion it may be stated that it was ascertained that the platinum light standard (B) produced the unit intensity of light (the unit of light equal to the light emitted by the standard candle) at a total expenditure of energy equal to 427 Ω ergs per second. Of these, 300 Ω ergs were actually transformed into light by heating the platinum up to a high temperature; while the remaining 127 Ω ergs were lost for illuminating purposes, being used for raising the temperature of the circuit exclusive of the platinum standard.

The platinum light standard (A) being made of much thicker platinum sheet, showed a much less favourable result. The unit of light by (A) was produced at a total expenditure of energy equal to 1,126 Ω ergs per second, of which 725 Ω ergs were actually transformed into light, the remaining 501 Ω ergs were wasted in heating the circuit to low temperature (no light). Considering that the unit of light can be produced in an electric arc at a total expenditure of energy of 10 Ω ergs per second only (see my *Précis of Report on Electric Light Experiments*, London, 1st Nov. 1878, p. 11), when produced by Siemens' intermediate dynamo-electric machine, it follows that, from an engineering point of view, light by *incandescence* can scarcely be expected to compete with light by *disintegration* (electric arc).

In fact, it appears that light by *incandescence* is scarcely any cheaper than light by *combustion*. The reason for this is that the temperature of an incandescent platinum wire is not very much higher than the temperature of a flame, and that for unit volume the mass which has to be kept up heated in a piece of platinum is much larger than the mass in a flame. Unless we should be fortunate enough to discover a conductor of electricity with a much higher melting point than platinum, and that the specific weight and specific heat of that conductor is also much lower than for platinum—and that at the same time the new conductor does not combine at high temperatures with oxygen, we can scarcely expect that the principle of incandescence will be made use of for practical illumination.

Further it was ascertained that the resistances of the platinum light standards (not including constant resistance) were as follows:—

P. L. S. (B) = 0·136 Ohm at 22·2° C.
= 0·876 ,, at the temperature of the standard,

where the light was measured, or increase $\frac{0{\cdot}876}{0{\cdot}136} = 6{\cdot}44$

P. L. S. (A) = 0·102 Ohm at 18·9° C.
= 0·964, ,, at the temperature of the standard,

where the light was produced, or increase $\frac{0{\cdot}964}{0{\cdot}102} = 9{\cdot}45$.

I regret that I have not been able to calculate from the above results the temperature of the heated platinum, since I could not procure in time a copy of Dr. William Siemens' Bakerian lecture (1871), which at present, to my knowledge, is the only source where the increase of resistance of platinum at high temperatures can be found.

To sum up:—

The advantages of the new standard of light are:—The light is perfectly constant if the current be kept constant; it allows a correction to be made for the variation of the current if this variation is known; it can be reproduced accurately everywhere if ordinary precautions be taken to secure pure platinum;* its magnitude can be altered to any extent to suit certain practical purposes by simply varying the elements of weight, shape, and size of the platinum, or the strength of the current passing through it; it does not alter of itself either in intensity, size, or position, and therefore by it most accurate photometric measurements can be executed; the standard can be easily made to fit into any adopted system of absolute units. Hence the new standard fulfils *all* the recognised conditions of a perfect and rational standard, and therefore it would be advisable to adopt it in future as the practical standard for light-measurement. There would be no practical difficulties met with in the introduction of the new standard for technical purposes.

* The conductivity of any metal is much lowered by slight impurities, and platinum does not form an exception. Hence great care must be exercised in the selection of platinum for the light standard. Dr. William Siemens in his Bakerian lecture says: "The abnormal resistance of some platinum is due chiefly to the admixture of iridium or other metals of the same group, and it appears that platinum prepared by the old welding process is purer and therefore better suited for electrical purposes than the metal consolidated by fusion in a Deville furnace."

CORRESPONDENCE.

THE MATERIAL NATURE OF ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am sorry that Mr. Sprague does not appreciate the grounds of my *reservation*, and however tempting it may be to reply I forbear until Mr. FitzGerald has completed his essay.

Meanwhile, a few remarks may not be out of place if kept strictly within my self-imposed limits.

The statement that "current is *actually current* in the sense that something analogous to a grain of water is actually transmitted," is not a "begging of the question" so much as a clear statement of fact supported by quantitative and qualitative analysis.

Mr. Sprague says:—"We know that metal or basyle is projected on one side, and we know that an equivalent 'cation' is set free on the other side—*that is fact.*"

This statement, emphasised by Mr. Sprague, may pass muster for the present, not only as *fact* but *material fact.*

By and by we shall require a clearer and fuller statement of what is essential in the matter, and what this equivalent "cation" means.

May we venture another remark as to the vague fashion of regarding light, heat, sound, and electricity as things or phenomena "*per se*" rather than as *effects* in immediate relation to their material or physical causes.

A bent spring is released, and sound vibrations radiate; a candle is combusted, and light-vibrations radiate. One is an affection of mass, the other is an affection of atoms; and the common term "vibrations" is misleading if entertained apart from such a fundamental difference of causation.

May we hope for the speedy return of Mr. FitzGerald from cloud-land; and that Mr. Sprague, who has done so much to simplify and consolidate electrical knowledge may ere long explain to us how electrical *effects* are produced by chemical actions controlled into the form of a linear circuit.—Yours, &c.,

SAML. E. PHILLIPS.

ANSWER TO CORRESPONDENT.

K. and S.—The use of a mixture of bichromate of potash in solution and sulphuric acid as a depolarising agent was, we believe, first suggested by Poggendorff. Any patent can relate only to the *mode* of using this agent, or to the construction of the cell. The bichromate of potash is probably, of all the salts of chromic acid, that which is least adapted for the purpose in view.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).

The half-yearly general meeting of the shareholders of the above Company was held on the 31st ult., at the offices, Cannon-street, under the presidency of Mr. Neil Bannatyne.

The MANAGER (Mr. Charles Gerhardi) having read the notice convening the meeting, the report, which appeared in *The Electrician* of last week, was taken as read.

The CHAIRMAN said that they would see from the accounts that so far as regarded their revenue everything had gone on very favourably up to the discovery of the first fault, which did not cause an interruption in their traffic, and even after that up till close upon the end of the year. Their total receipts up to the end of December, for the half year ending at that date, amounted to £7,405, which was a much larger sum than they had received in a similar period for a considerable number of years past. They could, therefore, well understand with what feelings of disappointment the Board had felt themselves compelled to issue their report, and to meet the shareholders on that occasion without the recommendation of any dividend either upon the preference or the ordinary shares. A fault of insulation occurred in the Bilbao cable last year, and although that did not stop the traffic, they had thought it advisable, as it might, if they continued to work, develop itself into a very serious fault, to have it repaired, especially as an opportunity presented itself of doing so under a favourable arrangement with the India Rubber Company, as their steamship, the Dacia, was on its way home from Algiers about that time. The total cost of the first repair was £2,190, from which, however, had to be deducted the value of the cable recovered, which sold very favourably, bringing them £1,185, and leaving £1,005 as the net amount to be charged to their profit and loss account for the repair of that fault. Matters then went on exceedingly well up to the end of December, when, very much to their surprise and chagrin, they received a telegram stating that the cable was broken. It could not have occurred at a more unfavourable juncture, for their receipts were going on in such an encouraging manner, and the weather at that time of the year was almost invariably unfavourable in the Bay of Biscay and on that coast. The report of the engineer on the expedition was not yet completed, but they knew that in consequence of the very unfavourable weather which prevailed the repair of the cable was rendered a very difficult task. However, it was now in thorough order, and the electrical condition of the cable was as perfect as it was before the fault

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was discovered—in fact, as good as it had been for many years past; and they cherished the hope that a repetition of the calamity was not likely to occur for even a longer period than between the last and the previous breakage—a period between five and six years. The probability was that they would not have a similar interruption for a longer period than that, and if so he thought they would recover the ground they had unfortunately lost at present; and that he thought was the more likely, as he was very happy to be able to inform them that since they resumed their traffic it had come back to them, and their receipts since the middle of this month, when the working of the Bilbao cable was resumed, were highly satisfactory. They had also an improvement over the Marseilles and Barcelona cable, which had continued up to now. Although their receipts were so considerable during the half year, the expenses did not exceed what they regarded as their normal amount—£2,000, which was the same when the receipts were much less. They did, in fact, all that they could to keep down expenses, and all that they could to increase the receipts. Their Bilbao traffic, he was happy to say, had developed wonderfully since the revival of the iron trade, and if that revival and the activity which was now going on continued, there was no doubt that it would a very great element in the future prosperity of the Company. He read an extract from a contemporary showing the rise in the price of iron ore free on board at Bilbao since June, 1879, when it was 5s. 6d. per ton, to the 24th of January this year, when it reached 16s. 10d. a ton. As the miners refused to take large contracts for future delivery, it was thought at Bilbao that 20s. per ton might become the ruling quotation. They could, therefore, readily understand how great the activity must be at Bilbao, and how much such a state of things would tend to increase the traffic of the Company. Their messages from Bilbao last week were, in fact, the largest they had had for the last five or six years. The total shipments of iron ore from Bilbao in 1879 amounted to 1,120,839 tons. The alteration in the system of charging messages would come into operation to-morrow (Thursday), and he might say, to justify their hope that some advantage would result to them from the adoption of the word rate, that in those cases where it had already been adopted for international communications, it had produced a large increase in receipts. He hoped it would have the same beneficial effect in their case. They had not received an account of the total expenses for putting the cable into thorough order.

Mr. ETLINGER having seconded the motion, a brief discussion followed.

The CHAIRMAN in reply said that they had formed an idea of the total cost of the repair of the cable, but he thought it better not to say anything definite till they got the accounts. They debited revenue with the net cost of the first repair. That left their reserve fund intact. What they had in hand belonging to profit and loss account to pay for the second job was £2,200, and the reserve fund of £4,450, together £6,650, and he thought he might say that what they had to pay would be covered by that, so that at the worst they started free. They expected to receive every day £5,000 from the Spanish Government for the third quarter of 1879, and after the interval of four or five weeks they would get the Christmas quarter. Their cables were now in full working order, the traffic was very satisfactory, and all they wanted was that no unforeseen calamity might occur.

Mr. MATTHEW GREY stated that from what he knew of the cable and its position he believed the chairman's calculation—that there would be no breakage again for some years—was a reasonable hope. He drew attention to a portion of the cable originally laid in 1872, and said it was in just as good order and condition as when it was laid.

The retiring directors (Mr. Etlinger and Mr. Scott) and the retiring auditor (Mr. J. Cowan) were re-elected; and

The CHAIRMAN then stated that but for the misfortune he had mentioned they would have been able to pay the 10 per cent. on the preference shares (the dividend on which is cumulative), have added a fair sum to the reserve fund, and have given a very fair dividend to the ordinary shareholders.

A vote of thanks to the chairman and directors closed the proceedings.

INDO-EUROPEAN TELEGRAPH COMPANY (LIMITED).

The annual general meeting of the shareholders of the above Company was held on the 31st ult. at the City Terminus Hotel, Colonel James Holland presiding.

The SECRETARY (Mr. W. Andrews) read the notice convening the meeting, and the seal was affixed to the register of shareholders. The report of the directors was taken as read. It stated, *inter alia*, that the Company's revenue from all sources for the year 1879 amounted to £86,358, the expenses to £45,790. After charging £7,232 per centage upon profits payable to Messrs. Siemens, under their maintenance contract, taking credit for the balance brought from last year, £939, and deducting income tax, there remained the sum of £33,837. From this amount the interim dividend of £10,625 already paid had to be deducted, leaving a nett balance of £23,212 available. The directors propose to declare a further dividend for the last six months of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year 1879, free of income tax. Following the course approved by the shareholders last year, the sum standing in the suspense account as payable to Messrs. Siemens, amounting to £2,588 had been credited to their account. Out of the remainder of £5,748, £5,000 was proposed to be added to the reserve fund, and the balance, £748 to be carried to the credit of the current year.

The CHAIRMAN, in moving the adoption of the report and accounts, said that they were, happily, in the predicament in which countries were said to be the happiest—they had no history. They had been carrying on their work in the past year in a fairly prosperous condition, not by leaps and bounds, but continuing the progress they made the year before. Last year he stated that they made the largest income they had ever received, but last year they had exceeded that income by about £1,100, and the outturn generally would have been still better if it had not been for what very often happened in the course of events—a few exceptional cases, but nothing of the slightest importance as affecting materially their interests. Their expenditure was only about £100 or £120 in excess of last year. A portion of the expenditure they might consider beneficial, while all of it had been necessary. Among other items of expenditure which might be regarded as beneficial was a sum of £1,178 they had spent on a freehold property they had acquired. They had had to rebuild their Sukhum station, and they had done the work substantially, and that expenditure, instead of "watering," had improved their property. They had also incurred some extraordinary expense by removing their offices, which they were obliged to do. Since the formation of the Company they had occupied premises which belonged to the Post Office, who gave them notice to remove. They had gone to excellent offices, on a very long lease, in about one of the best situations in London—the upper part of Old Broad-street, a very central position, and he only hoped that the Company would continue in them for many years, and do as well as they had been doing in the last three or four years. He had nothing to say on the accounts generally beyond what he had already stated. There were two items apparently large—sundry creditors £10,000, and sundry debtors £20,000. They were, however, all matters of regular floating account, and matters which were settled at the end of every month. He might say for their satisfaction that up to the end of last month the only debt owing to the Company was a sum of a few hundred pounds from the Indian Government, which they might consider pretty safe. They might rely on it that the figures shown were *bona fide*, and not "bogus." He then referred to the final settlement of a debt alluded to in the report with Messrs. Siemens, and gave an outline of the circumstances and how it arose. The total sum of £9,586, which was in the accounts under the head of suspense account would, some years hence, rank among their assets as part of a reserve fund. The only other fact that occurred to him to mention was that the telegraph conference had been held in London during the past year, and had settled telegraphic affairs for the next five years to the satisfaction, he believed, of most parties, and he was quite sure that the mercantile community would be very glad to know that there would be no reopening of telegraphic questions for five years. This Company had no reason to complain of what was done. They believed that although their interests were not specially considered yet what was done was reasonable and fair to all parties. As to the sum owing to them by the Russian Government on account of about 60 or 70 miles of cable which was destroyed during the war with Turkey, he regretted to say that up to the present they had not received it. The matter was still under discussion with the Russian Government, whose hands, of course, they could not force. They looked to that Government to do what was right, and he urged the shareholders to leave the matter in the hands of the Board.

Mr. W. H. BARLOW having seconded the motion, a short discussion took place.

Mr. W. FORD urged the advisability of the Company holding two general meetings a year instead of only one, and so follow the course of the majority of the public companies in England.

Mr. BEARD warmly supported the suggestion of Mr. Ford.

Mr. HOLZER, however, was opposed to the alteration suggested, but recommended that the receipts of the Company should be published weekly or monthly.

The CHAIRMAN, in replying, said it was a matter of indifference to the directors whether the meetings were yearly or half-yearly. Hitherto they had only been yearly, because no feeling had been expressed on the matter by the shareholders. They would not object to the change if it were desired by the largest shareholders generally. There was, however, a certain amount of inconvenience in half-yearly meetings, as their accounts were made up from all parts of the world.

Mr. FORD: So are the Eastern and the Eastern Extension Companies'.

The CHAIRMAN, continuing, said it was a difficulty which could, no doubt, be got over if the shareholders generally desired it. In this Company there was practically no Stock Exchange dealings—no gambling. The shares remained steady, and were held for investment, not speculation. The question of publishing the receipts periodically had been before the Board on more than one occasion, and they held that it was inexpedient to publish them. There was now a whisper of opposition to them from another company, which, however, did not exist at present. He would also ask, what was the use of giving the receipts without the expenses, and the expenses they could not state?

The report was then adopted unanimously, and the dividend recommended was declared.

The retiring directors—Major-General G. B. Tremenheere, R.E., and Messrs. J. Herbert Tritton and H. Weaver—and the retiring auditors—Messrs. C. F. Kemp, Ford, and Co.—were next re-elected.

Mr. FORD, in moving a vote of thanks to the chairman and directors, said that though he was at issue with them as to the holding of only one meeting a year, he was quite in accord with them as to the inexpediency of publishing the receipts. He thought that companies had been too free in this matter, and the interests of outsiders had been studied rather than those of the shareholders.

Mr. SKINNER seconded the motion, and eulogised the services of the directors and the constant attention they paid to the interests of the shareholders.

The CHAIRMAN returned thanks, and said they had tried to do their duty, and it was satisfactory to them to know that the shareholders believed that that was so.

The proceedings then terminated.

NEW PATENTS, 1880.

578. ELECTRIC LAMPS.—*T. A. Edison.*
583. ELECTRIC POWER APPLIED TO LOCOMOTIVES.—*(A communication.)—C. H. Siemens.*
630. ELECTRIC LIGHTING.—*Hon. R. T. D. Brougham.*
631. TELEPHONES, &c.—*(A communication.)—F. H. F. Engel.*
636. ELECTRIC LIGHTING.—*(A communication.)—A. M. Clark.*
638. ELECTRIC TELEGRAPHS.—*(A communication.)—W. R. Lake.*
671. RAILWAY TELEGRAPH.—*C. Darlstrom.*
695. ELECTRIC CABLES.—*(A communication.)—W. R. Lake.*

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699. ELECTRIC TELEGRAPHY.—*(A communication.)—W. R. Lake.*
725. ELECTRIC LIGHTING.—*(A communication.)—F. Imray.*
751. TELEGRAPH WIRES.—*(A communication.)—E. F. Cheesbrough.*
752. TELEPHONES.—*(A communication.)—E. F. Cheesbrough.*
756. ELECTRICAL WIRES.—*(A communication.)—A. W. L. Reddie.*
814. TELEPHONE WIRES.—*(A communication.)—F. H. Johnson.*
832. ELECTRIC LAMPS.—*Honourable R. T. D. Brougham.*
842. ELECTRIC LIGHT.—*(A communication.)—A. M. Clarke.*
849. DYNAMO-ELECTRIC MACHINES.—*(A communication.)—H. F. Haddon.*
860. MAGNETIC APPLIANCES.—*G. Green.*
872. MAGNETO-ELECTRIC MACHINES.—*D. G. FitzGerald.*
878. PNEUMATIC TELEGRAPHIC APPARATUS.—*(A communication.)—W. Morgan Brown.*
885. ELECTRIC LIGHTING.—*(A communication.)—F. Graddon.*
899 GALVANIC BATTERIES.—*(A communication).—A. M. Clark.*
925. ELECTRIC LAMPS.—*F. H. Guest.*
941. TELEPHONES.—*R. H. Courtenay.*

ABSTRACT OF PATENTS.

2575. TELEGRAPHIC APPARATUS FOR RAILWAYS, *E. Tyer.—Dated 26th June*, 1879. 6*d.*

This consists, first, in the use for transmitting telegraphic railway signals of an apparatus in which a commutator, caused to revolve with moderate speed until it is stopped by a peg inserted in a hole in a dial, determines the transmission of alternating electrical impulses proportioned in their number to the part of a revolution through which it has moved, thereby causing a proportional movement of a receiving index at a distant station. Secondly, in the use in combination with the transmitting apparatus of a receiving apparatus in which a polarised armature, caused to oscillate by the influence of the transmitted impulses on an electro-magnet, gives step-by-step movement to an index through a part of a revolution corresponding with that through which the transmitting commutator is moved.

2821. AUTOMATICALLY OPENING AND CLOSING ELECTRICAL CIRCUITS, &c., *G. Zanni.—Dated 10th July*. 1879. 6*d.*

This relates to a means for preventing a reversal of the polarity of the electricity employed in the process of the electro-deposition of metals.

2878. MANUFACTURE OF MAGNETIC STAYS, CORSETS, &C., *W. Wilson.—Dated 15th July*, 1879. 6*d.*

This consists in perforating the magnets with three or other number of holes to set up a local electric action when the magnets are fastened to the fabric by eyelets of suitable mixed metals, such as brass or other alloy.

3023. TELEGRAPH WIRES, *J. H. Johnson.—Dated 25th July*, 1879.—*(A communication.)* 4*d.*

This consists of a core of steel or homogeneous iron, and a clothing of wrought iron welded to and metallically united with the core.

3132. ELECTRICAL COMMUNICATION BETWEEN SHIPS AND SHORE, *S. Lauritzen, W. C. Johnson, and S. E. Phillips.—Dated 2nd August*, 1879.—*(Not proceeded with.)* 2*d.*

To enable a ship to communicate with the shore a cable is laid out to sea for a suitable distance, and the vessel is provided with a short length of cable, which trails along the bottom of the sea so that the circuit will be completed when the one touches the other.

3410. ELECTRIC BATTERIES, *W. Morgan-Brown.—Dated 25th August*, 1879.—*(A communication.)—(Complete.)* 6*d.*

This relates to a compound battery composed of two classes of elements, one with pushing and the other with attracting power, whereby the battery corrects itself in a great measure as to its polarisation.

3479. ELECTRIC SIGNALLING APPARATUS FOR RAILWAYS, *W. Robinson.—Dated 29th August*, 1879. 8*d.*

This relates to a section of railroad track and two batteries placed at opposite ends thereof and electrically connected thereto in combination with each other, and with a signal-operating magnet on a locomotive or car, the whole arranged in such a manner that when the locomotive reaches one end of the section of track it will cut off the battery at that end of the section by short circuiting or by opening the circuit (either or both), and at the same time receive an electric current through the magnet from the battery at the opposite end of the section of the track.

TRAFFIC RECEIPTS FOR FEBRUARY, 1880.

COMPANIES.	Feb. 1880.	Feb. 1879.	Incrse.	Decrse.
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	3,200 estd.	2,775	425	—
Direct Spanish Telegraph Company	—	—	—	—
Direct United States Telegraph Company	—	—	—	—
Eastern Telegraph Company	44,591	37,251	7,340	—
Eastern Extension Telegraph Company	25,190	22,40	2,781	—
Great Northern Telegraph Company	14,160	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—

TELEGRAPH SHARE LIST.

COMPANIES.	CLOSING PRICES MARCH 31.		BUSINESS DONE WEEK ENDING MARCH 31. Highest.	Lowest.
Anglo-American Ordinary	60¾,	1¼	60¾	59¾
Do. "B"	90,	½	90⅛	89
Do. "A"	33⅞,	4	34⅜	32⅝
Brazilian	7 13-16,	15-16	8	7⅞
Cuba	9¼,	¾	—	—
Do. Ten per Cent. Pref.	16,	⅛	—	—
Direct Spanish	2,	½	—	—
Do. Ten per Cent. Preference	10½,	11	10¾	10½
Direct United States	11⅜,	⅜	11¼	11¼
Eastern	9,	⅛	9⅛	9
Do. Six per Cent. Debenture	103,	6	—	—
Do. Five per Cent. do.	100,	2	—	—
Do. Six per Cent. Preference	12⅛,	⅜	12¼	12¼
Eastern Extension	8 15-16,	9 1-16	9	8 15-16
Do. Six per Cent. Deb.	105,	8	—	—
German Union	8⅓,	9	9	9
Globe Telegraph and Trust	5⅝,	¾	5⅞	5 9-16
Do. Six per Cent. Preference	11 7-16,	9-16	11⅝	11½
Great Northern	9⅝,	⅞	9⅝	9⅝
Indo-European	24,	6	24½	24½
Mediterranean Extension	3,	½	3¼	3¼
Do. Eight per Cent. Preference	10½,	11½	—	—
Reuter's	10,	11	—	—
Submarine	233,	8	—	—
West India and Panama	1⅜,	⅞	1 13-16	1 11-16
Do. Six per Cent. Preference	7¾,	8	—	—
Western and Brazilian	7⅞,	⅜	7¼	7 1-16
West. Union Seven per Ct. 1st Mt.	120,	5	—	—
Do. Six per Ct. Sterg.	102,	4	103½	103½

ADDRESSES.

*** NOTICE.—It has been decided to devote a portion of the advertising space of *The Electrician* to giving the addresses and specialities of the principal firms of Electricians, Engineers, &c. A moderate charge per annum will be made for the insertion of such addresses weekly, and firms desirous to be included in the list are requested to apply to the Manager, 396, Strand. The addresses must not occupy more than five lines.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

PETER BROTHERHOOD, Engineer, 56 and 53, COMPTON-STREET, GOSWELL-ROAD, E.C.
Specialities—Patent 3-Cylinder Engines (Silver Medal, Paris), as used by Siemens, Gramme, and Wilde for driving Electric Machines.

RANSOMES, SIMS, and HEAD, Orwell Works, IPSWICH.
Specialities—Portable and Stationary Engines, fitted with patent governors, as tried in the electric lighting experiments on the Thames Embankment.

ABBOTT and Co., NEWARK-ON-TRENT.
Specialities—The "Standard Size" Vertical Cross Tube Boilers. Illustrated catalogue, giving every detail of a variety of Boilers 2s. 6d., post free.

CARBON ELECTRODES COMPANY. Works: 39, COMMERCIAL-ROAD, EAST.
Specialities—Carbon Rods of all sizes for Electric Lighting. Also, Plates and all other Moulded Carbon Goods. List of prices on application.

M. THEILER & SONS, Telegraph Instrument Manufacturers, 86, CANONBURY-ROAD, N. Works: ALWYNE-LANE, N.
Specialities—Morses, Polarised Relays, Saunders' Curb Keys, Type Printers, Recording Sounders, Duplex Apparatus (Theiler's Patent).

HOOPER'S TELEGRAPH and INDIA RUBBER WORKS, MITCHAM and MILLWALL DOCKS.
Contractors for the Manufacture and Laying of Submarine Telegraph and Torpedo Cables. Manufacturers of Hooper's celebrated Insulated Core. Printed reports on application. Offices: 31, LOMBARD STREET, LONDON, E.C.

THE BRITISH ELECTRIC LIGHT COMPANY (Limited), 41, PARLIAMENT-STREET, WESTMINSTER, and 17, WATER-STREET, LIVERPOOL.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

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SLIP

THE ELECTRO-MOTOR TELEGRAPH.—Edison has sold his electro-motor telegraph to the Western Union for £20,000.

GREAT NORTHERN TELEGRAPH COMPANY.—The receipts for 1879 were £222,493, the expenses £63,970.

THE BRUSH SYSTEM.—This system has been adopted by Messrs. Peek, Frean, and Co., the biscuit manufacturers, to light their factory.

DR. C. W. SIEMENS.—This distinguished electrician has been elected an honorary member of the American Institute of Mining Engineers.

THE TELEGRAPH IN THE EAST.—China has established a telegraph line from Pekin to the Russian frontiers, in case of war with the latter power.

THE ROYAL SOCIETY.—Messrs. Spottiswoode and Moulton on Thursday read Part II. of their paper "On the Sensitive State of Vacuum Discharge."

"THE ENCYCLOPEDIA BRITANNICA."—Sir William Thomson is writing the articles on pressure gauges and thermometry for the *Encyclopedia Britannica*.

THE EASTERN TELEGRAPH.—The directors recommend an interim dividend of 2s. 6d. per share for the quarter ended 31st December, 1879, being at the rate of 5 per cent. per annum.

THE VICTORIA DOCKS.—We do not know how many tenders were sent in for lighting these docks by the electric light, or the amount of the various tenders, but we have heard that the amount of one tender was considerably over £30,000.

THE DIRECT UNITED STATES CABLE COMPANY (LIMITED).—The Direct United States Cable Company (Limited) notify that the interim coupon for interest to 15th April, on their Six per Cent. Debenture Loan, will be paid on and after that date at the Consolidated Bank, 52, Threadneedle-street, London, E.C.

THE WIRE AGE.—The *Boston Journal of Chemistry* calls the present epoch the "wire age," from the multitude of wires to be found in the world for telegraphic and other purposes. The part played by wires is indeed important, and our American contemporary has the merit of recognising it in a distinct manner.

THE ELECTRIC LIGHT.—The Montreal Electric Lighting Company will apply to the Legislature of the Province of Quebec at its next Session for an Act of Incorporation for the Montreal Electric Light Company, with power to furnish in the city and district of Montreal light and motive power generated from electricity.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The number of messages passing over the lines of the Cuba Submarine Telegraph Company (Limited), during the month of March, was 3,247, estimated to produce £3,500, against 2,818 messages, producing £3,256 in the corresponding month of last year. The traffic receipts for the month of January, estimated at £3,200, realised £3,406.

BRUSSELS.—At the National Exhibition to be held this year in commemoration of the fiftieth year of Belgian Independence, Class VII., of the second group of the first section, is devoted to electrical and telegraphic apparatus. This will include telegraphic apparatus founded upon the transmission of light, sound, &c.; material of electric telegraphs —batteries, senders, receivers,; electric bells; military telegraphs; telephones; megaphones; microphones, &c.

METEOROLOGICAL OBSERVATIONS AT BARROW.—Sir James Ramsden, to whose energy and perseverance the remarkable rise of the town of Barrow may be mainly attributed, proposes to establish and to maintain a meteorological observatory, with a telegraph reporting station, at Barrow-in-Furness. The Meteorological Council have, of course, accepted Sir J. Ramsden's generous offer, which is peculiarly acceptable, seeing that between Liverpool and Ardrossan they have no telegraphic station.

THE DRACHENFELS.—As an experiment, the German Postal and Telegraphic Department is about to open for use during the coming summer a telephone connecting the top of the Drachenfels with the charming riverside resort of Königswinter, on the Rhine. The wire is laid along the foot road by way of Hardtberg and Kuckstein to the refreshment house beneath the ruins. The project which was started some time ago of a railway up the Drachenfels, like that on the Rigi, is given up for the present, if not entirely abandoned. We are unable to see the use of the telephone in such a position. It is hardly to be expected that visitors will require to send messages, and they will not care to use the telephone as a curiosity.

SOCIETY OF TELEGRAPH ENGINEERS.—We are requested to mention that in consequence of the unavoidable absence of Dr. C. W. Siemens his paper "On the Application of the Dynamo Electric Current to the Fusion of Refractory Materials in Considerable Quantities," which it was stated by the President at the last meeting would be read on the 14th inst., is postponed until the 28th inst. The papers to be read on the 14th are:—1. Note on some Effects Produced by the Immersion of Iron and Steel Wire in Acidulated Water. By Professor D. E. Hughes, member. 2. Note on Professor Hughes' Communication. By W. Chandler Roberts, Esq., F.R.S. 3. On the Adhesion of Metals Produced by Currents of Electricity. By Augustus Stroh, member.

NEW CALEDONIA.—A terrible cyclone visited the island on January 26, doing immense damage at sea, on the coast, at Noumea, and in the interior. Fourteen vessels had disappeared, and it was supposed had foundered. During the height of the storm signals of distress were made from the war steamer Caledonienne, but no one dared approach, and it was feared that she had been lost, but she succeeded in living through the storm. Stone buildings were destroyed, though a lighthouse eighty feet high withstood the tempest. The barracks at the Isle de Nou were levelled to the ground, rivers rose, and bridges and telegraph lines were carried away. The Government had given 100,000 francs for the relief of sufferers, and 400 soldiers were sent to aid in the work of rebuilding.

THE TELEPHONE AND DEAFNESS.—Some writers on science do not seem to know it has long been well understood that certain forms of deafness are partially remedied by receiving the sounds through the mouth. The ticking of a watch, which cannot be heard when the watch is placed against the ear, is audible when the watch is put into the mouth, and so on. The Milwaukee *Sentinel*, when describing the Elgin Acoustic Telephone, says:—"It is extremely simple and economical in construction." The article states:—"But the most wonderful test is the one which has been tried of getting at such a distance from the instrument that by no possibility can sounds be heard, and then taking the wire between the teeth. A person quite deaf can understand words spoken in a moderate tone, the effect being the same as follows from the use of an audiphone."

AN AUTOMATIC SENTRY.—An American journal gives a description of a life-size automaton which, on being duly

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wound up, paces too and fro, rifle on shoulder, and with an unexceptionable military stride. In the interior there is an electric apparatus which administers a severe shock to any one who meddles with the figure. The great difficulty encountered by the inventor was in making the figure halt and return on its beat. During the preliminary experiments it bolted "as if bound for the home of the setting sun," as the journal poetically expresses it, and the owner had to mount a "living young mustang" and chase the flying Hiawatha. The mechanism requires to be wound up every two hours, and is lubricated in all parts by pouring oil down its throat, a trait which the inventor has avowedly copied from "thirsty" Christians. What the object of such a sentry is the American organ does not say. He might be usefully employed in keeping ignorant journalists out of laboratories and workshops.

The British Museum and the Electric Light.—On Saturday morning orders were received to remove all the lamps in the reading room of the British Museum and the approaches which have been used during the last three months in conveying the electric light and enabling readers to remain in the Museum library up to seven p.m. During the month of April, therefore, the reading room will be closed at six o'clock every evening, to which hour the galleries will also remain open. The electric light has, however, been such an eminent success as an experiment that the temporary lamps will be substituted by permanent ones, and these will be extended to all parts of the Museum, so that during next winter the public can be admitted up to six or seven o'clock every evening. Great disappointment has been expressed by the authorities at the delay in removing the natural history and zoological departments from the British Museum to the new museum at South Kensington, which was specially built for this purpose, and was ready for their reception in February last; but orders were received from the Treasury, and repeated on Saturday, that matters must remain *in statu quo*, from the simple fact that no money had been voted to cover the extra expense of removal.

Parody.—There seems to be a popular misapprehension about conversing through a telephone. It is not necessary to roar into the instrument so that you can be heard eight blocks away. The telephone don't work on that principle. If you are talking to a man, don't yell so as to disturb all peaceable citizens. Stand back two or three feet from the mouthpiece of the transmitter, and speak slowly and distinctly in your ordinary voice. The telephone is not deaf. Don't cry "hello" in bill-board type; rather whisper it in minion.

> Do not saw the air too much with your
> Mouth, thus; but use all gently;
> For in the very torrent, tempest, and (as I may say)
> Whirlwind of your passion you must
> Acquire and beget a temperance
> That may give it smoothness.
> Oh, it offends me to the soul
> To hear a robustious, periwig-pated fellow
> Tear a telephone to tatters, to very
> Rags; to split the ears of the boys
> At the central office, who for the most part
> Are capable of nothing but inexplicable
> Dumb show and noise—especially noise.
> I would have such a fellow whipt
> For o'erdoing Termagant.
> It out-Herods Herod.
> Pray you avoid it.

(Picked up adrift.)

Syracuse, U.S.A.—"An amateur fireman of Syracuse, a recent graduate of Cornell University, has been made fire commissioner of that city, in recognition of his services to the fire department. It is his hobby to keep, at private expense, a large chemical engine and outfit of horses and men. The engine house is as elegant in its appointments as a private house. Fifteen seconds, at the outside, after the alarm is sounded, the engine is on its way to the fire. Electricity is most ingeniously employed. When the key is applied to an alarm box in any part of the city, many things are performed automatically at the engine house; the fire number is told by an indicator, while at the same time it is being rung out on a gong and registered on a tape to prevent mistake; the clock stops, and a second hand is started to register the length of time consumed in getting away; the gas is turned on, the clothes are pulled off the beds, and the sleeping-room door opened; the horses are unhitched, and as they go to their places, the whiffletree, which is suspended over each horse's back, follows a rod and slips down to its place on the engine; only four snaps to the reins, and poles must be adjusted by hand; and the front doors which opened automatically, close by the same agency, after the engine passes out." Our correspondent has unfortunately neglected to state the paper from which the above extract is taken, so that we are unable to give credit where credit is due.

Electrical Telemeter.—In the ingenious apparatus devised by M. G. Le Goarant de Tromelin, of the French Navy, for the purpose of determining at any moment the distance of a movable and inaccessible object, two sides of a triangle are indicated by a telescope through which the object is observed from station A, and by a base line, say 1,000 metres in length, between this station and another station B, at which the object is observed through a second telescope. On the base line and at a distance, say of one metre from the terminal point, about which moves the telescope at A, is pivotted a pointer which, by means of a succession of currents produced whenever the telescope at B is moved, is consequently maintained exactly parallel with this instrument. It will be seen that this pointer gives at station A the third line of a triangle exactly 1,000 times smaller than that formed by straight lines from the inaccessible object C to the extremities of the base line between the station A and B. The pointer may thus be made to indicate on a scale at A the exact distance at any moment of the movable object, whenever the observers at A and B are *both* at their posts. The apparatus for the transmission of the currents from B is somewhat similar to that in the alphabetical instrument of Messrs. Siemens; whilst in the receiver at A a shaft carrying an endless screw is influenced by two electro-magnets, so as to move a toothed wheel, to the axis of which is attached the pointer which is maintained parallel with the direction of the telescope at B.

The Romance of the Wire.—Here is a tit-bit for telegraphists from a speech by the late Hepworth Dixon, author of "New America," &c.:—"As with the steamship so with the telegraphic wire. Marking a telegraphic wire in the London street, trailing by lampposts, crawling near gutters, you reject the poetry that palpitates in that wire! Let us leave this question open. The familiar is rarely picturesque. No Venetian artist thinks a gondola picturesque. No English artist thinks a cab picturesque, but English artists flock to the lagoons in order to paint gondolas, and a famous Venetian artist has recently been in London for the purpose of painting cabs. Set the wire in a strange scene, and we catch the picture at a glance. In the Syrian desert you come on the telegraphic line connecting London with Calcutta by way of the Euphrates Valley. You may find a Bedouin Sheikh standing near it with a carbine in his hand, a dozen of his

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servants by his side, his mare and camels in a group apart, and the wild bit of wire—to him a Sheitan's messenger—running through the wild man's country, and a black bird perched on one of the telegraph poles, an emblem of that Sheitan which the untamed Arab Sheikh conceives—alighted on his throne! Is there no poetry in that bit of wire? That wire at which the bird pecks and the Arab glares, is thrilling with a thousand human emotions—a word of whispered love from separated hearts; a dying mother's blessing to her son; a desperate merchant's order to buy or sell; a Minister's command to levy war. Who knows? All kinds of messages are streaming on that line at which the blackbird nibbles and the Bedouin hesitates to fire. The same thing, in an equally poetic aspect, may be seen among the Rocky Mountains and along the arid plains of Santa Fé. Through desolate hunting grounds, on which the Sioux and Osages chase their prey and scalp their enemies, the wire runs forward, wedding the wealth, energy, and civilisation of New York and Boston with the growing wealth, energy, and civilisation of Sacramento, San Francisco, and Los Angelas. When you see how we girdle the earth in a few minutes—how we throw our chains over the wildest chasms, making the wild inhabitants of these waste places wonder and inquire—the first steps towards their better knowledge and their ultimate civilisation—can you say that there is no quickening spirit in that wire, no poetry and drama in that electric spark?"

Electric Lighting.—Some important and interesting experiments have been carried out in connection with the Jablochkoff system of electric lighting by Mr. J. A. Berly, the engineer to the Société Générale d'Electricité. They were conducted at the Victoria Station of the Metropolitan District Railway, where the Jablochkoff system of electric lighting was introduced towards the close of last year. About that time Mr. Berly had the two rails of the up-line connected together by a copper wire (insulated), both at Charing Cross and at Victoria Stations. He also had the two rails of the down-line connected up in the same manner. He tried experimentally: (1) to maintain five lights on the up-circuit, using the up-line as return wire; (2) to maintain five lights on the down-circuit, using the down-line as a return wire, and succeeded. Subsequently he carried out the lighting of the station with one main wire only in each circuit, and the rail as the return wire in each circuit. In the third place, Mr. Berly tried to maintain five lights on the up-platform circuit, using the up-line as return at Charing Cross, and the down-line as return at Victoria; and in the fourth place to maintain five lights on the down-platform circuit, using in a similar way the down and up lines as return. Both succeeded separately. He then lighted the station with both circuits connected, as explained in the third and fourth experiments, which was done successfully. Later on, namely, on the 2nd and 4th inst., he joined, experimentally, the two wires of Victoria Station into one, making, therefore, a total circuit of about seven miles of wire. He maintained, in the middle of that distance, that is $3\frac{1}{2}$ miles from the Gramme machine, five lights burning, and by the side of which he kept burning another five lights mounted on a circuit of about 250 yards of wire. He reports that both circuits appeared to burn with the same brilliancy, and the candles on the short circuit burned very little quicker than those on the long one. With regard to the progress of the Jablochkoff light on the Continent, we understand that the Paris Municipal Council has renewed for one year (expiring 1st March, 1881) the contract for lighting the Avenue de l'Opera, the Place de l'Opera, and the Place du Theâtre Français, with the Société Générale d'Electricité. The Sous Secrétaire d'Etat at the Ministère des Beaux Arts has just given the necessary authorisations to the Société for re-lighting the Salon at the Palais de l'Industrie in June next. The Hippodrome, which has been lighted for the last two years with sixty Jablochkoff lights and twenty Serrin regulators, will be lighted now by means of 128 Jablochkoff lights, the twenty Serrin regulators being replaced by sixty-eight Jablochkoff lights. The application of the system has extended to a number of industrial establishments in France and elsewhere since the commencement of the present year, and including the celebrated Creusot Works.—*Iron.*

Suppositions or Hypotheses; their Uses and their Value. — In Professor Huxley's "Introductory Science Primer," a book long promised but only recently published, there is a paragraph with the above title. The peculiar nature of electrical science renders "hypotheses" more than ordinarily useful in its study, and though we are taunted sometimes with the remark that we deal with hypotheses too much, we may in future invoke another weapon to our armory from Professor Huxley's work in support of such extensive use. The latter part of Professor Huxley's remarks, however, must never be forgotten. The following is the passage referred to:—"When our means of observation of any natural fact fail to carry us beyond a certain point, it is perfectly legitimate, and often extremely useful, to make a supposition as to what we should see, if we could carry direct observation a step further. A supposition of this kind is what is called a hypothesis, and the value of any hypothesis depends upon the extent to which reasoning upon the assumption that it is true enables us to explain or account for the phenomena with which it is concerned. Thus, if a person is standing close behind you, and you suddenly feel a blow on your back, you have no direct evidence of the cause of the blow; and if you two were alone, you could not possibly obtain any; but you immediately suppose that this person has struck you. Now that is a hypothesis, and it is a legitimate hypothesis, first, because it explains the fact, and secondly, because no other explanation is probable; probable meaning in accordance with the ordinary course of nature. If your companion declared that you fancied you felt a blow, or that some invisible spirit struck you, you would probably decline to accept his explanation of the fact. You would say that both the hypotheses by which he professed to explain the phenomenon were extremely improbable; or, in other words, that in the ordinary course of nature fancies of this kind do not occur, nor spirits strike blows. In fact, his hypotheses would be illegitimate, and yours would be legitimate; and, in all probability, you would act upon your own. In daily life, nine-tenths of our actions are based upon suppositions or hypotheses, and our success or failure in practical affairs depends upon the legitimacy of these hypotheses. You believe a man on the hypothesis that he is always truthful; you give him pecuniary credit on the hypothesis that he is solvent. Thus, everybody invents, and, indeed, is compelled to invent, hypotheses in order to account for phenomena of the cause of which he has no direct evidence; and they are just as legitimate and necessary in science as in common life. Only the scientific reasoner must be careful to remember that which is sometimes forgotten in daily life, that a hypothesis must be regarded as a means and not as an end; that we may cherish it so long as it helps us to explain the order of nature; but that we are bound to throw it away without hesitation as soon as it is shown to be inconsistent with any part of that order."

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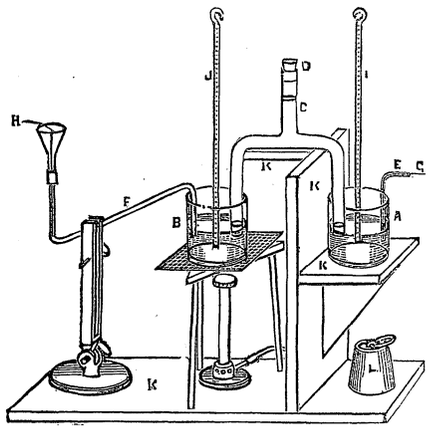
THERMO-ELECTRIC BEHAVIOUR OF AQUEOUS SOLUTIONS WITH MERCURIAL ELECTRODES.

BY G. GORE, LL.D., F.R.S.*

In order to investigate this subject I devised and constructed the following apparatus:—A and B are two thin glass basins, 81 millims. internal diameter (= 5,153 sq. millims. of mercury surface), and 6·0 centims. deep; each containing a layer of mercury about 1·0 centims. deep, covered by a layer about 3 centims. deep of the aqueous solution to be examined. C is a thin bent glass tube, about 3 centims. diameter, filled with the liquid, and closed by means of a bung at D. E and F are stout glass tubes,



about 2 millims. bore, E having a platinum wire sealed into it at its lower end, and F being filled with mercury; the ends of these tubes are usually placed in the mercury previous to adding the liquid, and F is fixed so that the solution cannot enter it. G and H are terminal wires of platinum, touching the mercury but not the liquid. I and J are thermometers, with their bulbs immersed in the pools of mercury. Each cup is closed by a bung (not shown in the sketch) to prevent loss of liquid by evaporation, also to support the thermometer and keep the tubes steady. The dish B is supported on wire gauze placed upon an iron tripod, with a Bunsen's burner beneath, and A is placed on a shelf level with it. KKKK is a wooden frame for supporting the apparatus, and L is a weight to keep it steady. This kind of apparatus was used in all the experiments, and acted very satisfactorily. I devised one of different construction for a similar purpose many years ago. (See *Phil. Mag.*, June, 1859).

The mercury employed was prepared by distilling the ordinary metal twice, then shaking it strongly in succession with dilute nitric acid, water, solution of cyanide of potassium, distilled water, and filtering it. Distilled water was used in making all the solutions.

In using the apparatus, the mercury was first poured into the basins; the tubes E and F placed, taking particular care that the mercurial column in F and its contact with the pool were complete. Two very shallow india rubber bungs were next inserted in the lower ends of the bent tube C, the tube then put in position, and filled with the liquid. The solution was now put into the basins, the bung D inserted tightly, the shallow ones then removed, and the bungs inserted in A and B. The completeness of the circuit was next tested by attaching a galvanometer to the instrument, and, if necessary, a minute swing of the needle was obtained by repeated connection at proper intervals of time. B was now heated. About seven or eight minutes was usually occupied in raising its temperature the required number of degrees; the deflections at the various temperatures being noted. After an experiment had been made, the mercury and solution of both vessels were mixed and cooled, and the mercury filtered, before repeating the trial with the same liquid.

Care was taken to select solutions which had the least amount of chemical action upon the mercury; those of salts of the heavy and less positive metals were, therefore, not employed. No liquid was used which produced any visible film or dulness upon that metal when heated with it. It was found necessary to heat each solution to about 180° F, and keep it at that temperature some little time to expel dissolved air, and then cool it previous to making experiments, otherwise the results obtained in repetition experiments were not quite uniform. In a previous research on the thermo-electric properties of liquids ("Proc. Roy. Soc." No. 188, 1878, pp. 513—543), in which platinum electrodes were employed, such previous heating was less necessary, probably because the thermo-electric currents were then stronger. After heating and cooling the liquid, it was freely shaken with the mercury, and then filtered, previous to making experiments with it. With every liquid, one or more repetition experiments were made in order to obtain uniform results, and confirm their reliability; the amount of difference of deflection of the needles in such experiments did not exceed one degree. The galvanometer employed was an astatic one, having two coils, each of 50 ohms resistance, the two being connected and used as one of 100 ohms resistance.

I have ascertained by separate experiments of a different kind that mercury, when sufficiently agitated with solutions, neutral to test paper, of salts of the alkali metals, renders some of those liquids feebly alkaline; the effect, however, is so slight, requires such extensive and long-continued contact of the substances, that it appears consistent with the view that chemical action is not the cause of the currents in these thermo-electric experiments.

By arranging the results in a series with the solution at the top, in which the hot mercury was the most positive at 180° F., and that at the bottom in which it was most negative, the following order was obtained. The horizontal line separates those liquids in which the hot metal was positive from those in which it was negative.

	Amount of deflection.
1. Phosphate of ammonium	28·0+
2. Carbonate of sodium	19·0
3. Sulphite of sodium (50 grs.)	13·0
4. Sulphate of ammonium	12·75
5. Carbonate of potassium	12·0
6. Sulphate of potassium	12·0
7. Borax	10·5
8. Nitrate of potassium	10·0
9. Nitrate of strontium	10·0
10. Selenate of sodium	8·0
11. Phosphate of sodium	8·0
12. Nitrate of barium	7·5
13. Nitrate of sodium	6·0
14. Formiate of sodium (100 grs.)	6·0
15. Microcosmic salt (50 grs.)	5·0
16. Formic acid (80 minims)	5·0
17. Nitrate of ammonium	4·25
18. Formiate of sodium (50 grs.)	4·0
19. Selenic acid (20 minims)	3·75+
20. Formic acid (40 minims)	3·5
21. Sulphate of sodium	2·5
22. Sulphite of sodium (10 grs.)	2·5
23. Microcosmic salt (100 grs.)	2·0
24. Boracic acid	2·0
25. Selenic acid (10 minims)	1·5
26. Sulphuric acid (1 in 80)	1·25—
27. Ammonia alum (50 grs.)	2·0
28. Cyanide of potassium (2½ grs.)	2·0
29. Hyposulphite of sodium	4·0
30. Ammonia alum (100 grs.)	4·0
31. Sulphuric acid (1 in 20)	6·25
32. Sulphuric acid (1 in 40)	6·75
33. Sulphite of potassium	9·0
34. Cyanide of potassium (5 grs.)	14·0
35. Cyanide of potassium (50 grs.)	45·0
36. Cyanide of potassium (100 grs.)	50·0

To ascertain whether this order agreed with that of a series arranged according to the different degrees of electromotive force of the various couples, I simultaneously employed two apparatuses similar to that already described (but with basins of 75 millims. internal diameter), charging one of them with one solution, and the other with another which was next to it in the above series, connecting them with the two wires respectively of the differential galvanometer, so that their currents circulated in opposite directions through the coil of that instrument, and ascertaining which gave the strongest current at 160° F. By this means the following series was obtained, in which the couple giving the strongest positive current is at the top, and that giving the most powerful negative current at the bottom, as in the previous list. The horizontal line separates those liquids in which the hot metal was positive from those in which it was negative. The relative positions of the solutions in the two series, although they agree in the main, are not identical; for instance, nitrate of potassium occupies the eighth place in the first series, and the second place in the second series; phosphate of ammonium, sulphate of ammonium, &c., are also changed in position. Such changes were probably affected by the circumstance, that whilst in the first series the electrodes were 81 millims. diameter (=5,153 sq. millims. of surface), and the current from a single apparatus circulated through a continuous double length of wire in the coil of the galvanometer, in the second series the electrodes were only 75 millims. diameter (= 4,418 sq. millims.), and

* Abstract of a Paper presented to the Royal Society.

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the current from a single apparatus circulated through a single half length of the coil. The temperatures at which the deflections were noted were also different in the two series. The surface of one electrode in the smaller apparatus was about $\frac{1}{16}$, and in the larger one $\frac{1}{14}$ of that of one of the platinum electrodes in the apparatus already referred to.

	Difference of amount of deflection.
1. Sulphate of ammonium	1·0+
2. Nitrate of potassium	3·0
3. Phosphate of ammonium	3·0
4. Sulphite of sodium (50 grs.)	0·75
5. Carbonate of sodium	1·0
6. Carbonate of potassium	1·5
7. Sulphate of potassium	0·25
8. Nitrate of strontium	0·25
9. Phosphate of sodium	0·25
10. Borax	1·5
11. Selenate of sodium	1·5
12. Nitrate of barium	0·25
13. Nitrate of sodium	1·0
14. Formiate of sodium (100 grs.)	1·0
15. Microcosmic salt (50 grs.)	0·75
16. Formiate of sodium (50 grs.)	0·75
17. Formic acid (80 minims)	2·0
18. Nitrate of ammonium	1·5
19. Sulphate of sodium	0.25
20. Sulphite of sodium (10 grs.)	0·25
21. Microcosmic salt (100 grs.)	2·0
22. Boracic acid	
23. Ammonia alum (50 grs.)	very slight —
24. Cyanide of potassium ($2\frac{1}{2}$ grs.)	0·75
25. Ammonia alum (100 grs.)	1·0
26. Hyposulphite of sodium	1·0
27. Cyanide of potassium (5 grs.)	13·0
28. Cyanide of potassium (50 grs.)	2·25
29. Cyanide of potassium (100 grs.)	

Remarks.—Many of the remarks which I have made in a previous paper on the thermo-electric properties of liquids ("Proc. Roy. Soc." No. 188, 1878, pp. 535-538) respecting the cause of the currents, apply to the results obtained in the present research; and I consider that the causes of the currents and of their direction are similar in the two cases.

On examining the results it will be observed that the effects are not manifestly related to the chemical nature of the solutions; thus, the liquids in which hot mercury is positive include those of acid, as well as those of alkaline reaction; and similarly with the solutions in which cold mercury is positive. To what extent chemical action occurred in the experiments and operated as a cause of electric currents, would be a difficult point to completely prove, because the amount required to produce such feeble currents would be so extremely small; the result of a general examination of the phenomena, however, does not support the hypothesis that the currents were of chemical origin.

The evident cause of the currents was heat, and the direction of them was probably due to molecular changes in the liquid attendant upon alteration of temperature. In nearly all cases the magnitude of the current increased with the amount of difference of temperature; the apparent, but not real, exceptions were those in which a reversal, or an advance towards it, occurred.

The strength of the solution manifestly affected the quantity, and in some cases the direction of the current, as may be perceived with the solutions of potassic cyanide (Nos. 1, 2, 3, and 4), selenic acid (Nos. 5 and 6), ammonia alum (Nos. 9 and 10), formic acid (Nos. 11 and 12), sulphuric acid (Nos. 15, 16, and 17), and phosphate of sodium and ammonium (Nos. 33 and 34). If the cause of the current, in the case of sulphuric acid, was chemical action, the direction of the current would probably not have been reversed by mere alteration of temperature, or by variation of strength of the mixture. If, also, the cause of the currents in general was of a chemical nature, the currents would probably have been stronger, especially with the stronger solutions, and would have increased in all cases, with the strength of the solution, until the latter was much more concentrated than those which were employed.

Stirring either portion of the liquid influenced the deflection in 59 cases out of 72, increased it in 49, and decreased it in 10 of those cases. Stirring the cold portion altered the current in 31 cases out of 36, and stirring the hot portion changed it in 28 cases out of 36. Stirring the cold portion also had a greater average magnitude of effect upon the current than stirring the hot portion. Stirring a liquid of acid reaction increased the current in 13 cases out of 20, decreased or reversed it in 3 cases, and had no effect in 4 cases. Stirring an alkaline one increased the deflection in 12 cases out of 24, decreased it in 5, and had no effect in 7. The effects of stirring upon the amount of deflection were greater in alkaline liquids than in those of acid reaction.

Influence of Previously Heating the Solution.—Having observed, even with solutions formed with water which had been preboiled to expel dissolved air, that unless such liquids had been further heated to 180° F. (and cooled), after the salt, &c., had dissolved, the currents obtained in successive experiments with such a solution were not quite uniform in amount, but always decreased, I examined this circumstance.

Twenty ounces of distilled water were boiled and cooled; the salt to be employed was then dissolved completely in it, and the solution shaken with pure mercury. The mixture was then divided into two equal portions, one of those portions raised to a temperature of 180° F. in a covered glass vessel, and the evaporated water condensed and returned to the mixture, so that the solution remained unaltered in composition; the liquid was then cooled. These preheated and non-preheated portions were employed respectively to charge the two apparatuses already described. The two thermo-pairs were then simultaneously excited, their currents allowed to circulate in opposite directions through the coils of the galvanometer, and the deflection noted when the hot portions of the two liquids had simultaneously acquired a temperature of 160° F. The following is a brief statement of the results :—

Twenty ounces of distilled water and 200 grs. of crystals of sodic phosphate. The non-preheated portion of solution yielded the strongest current; deflection 1°.

Twenty ounces of water and 2 drms. of sulphuric acid. The non-preheated portion gave the strongest current; deflection ·25°.

Twenty ounces of water and 100 grs. of partly dehydrated sodic carbonate. The non-preheated portion gave the strongest current; deflection ·33° at 140° F., and ·25° at 160° F.

Twenty ounces of water and 200 grs. of baric nitrate. The non-preheated portion yielded the strongest current; deflection 1°.

The same mixture as the last; one portion of the solution was preheated with mercury, instead of being preheated alone. The non-preheated portion gave the strongest current; deflection 1° at 180° F.

In each of these five experiments the non-preheated portion of liquid yielded the current of greatest electromotive force. This accords with the original observation that repetition experiments always yielded weaker currents.

In order to ascertain whether preheating the one portion of salt before dissolving it had the same effect upon the current as heating it after having been dissolved, the following experiments were made :—Preboiled and cooled 20 ozs. of distilled water, and divided into two exactly equal portions. Took two portions of 50 grs. each of partly dehydrated sodic carbonate; heated one portion to 180° F. for fifteen minutes until it ceased to evolve moisture (it lost 12·4 grs.), and cooled it. Dissolved the two separate portions of salt in the separate quantities of water, and tested the solutions against each other in the two apparatuses. No difference of strength of current occurred at any temperature up to that of 180° F.

In another experiment of this kind, 200 grs. of ammonia alum were divided and treated as above. The solution of the non-preheated portion gave the strongest current; deflection ·75° at 180° F.

Remarks.—The conclusion I draw from these last two experiments and results, combined with those of the previous ones, is that preheating the salt either before or after solution usually weakens the current, both in thermo-electropositive and in thermo-electronegative liquids.

In the several classes of cases described in this paper, it is evident that the currents are not due to chemical action, but to heat acting upon and altering particular molecular structures, and that the difference of electromotive power in different liquids is not due to differences of chemical action, but probably to differences of molecular arrangement of the solutions. Also that in the class of experiments where the liquids compared had the same chemical composition, but had been differently treated, the differences of molecular arrangement were less, and the currents obtained were consequently more feeble. A difference of strength of current caused by repetition of experiments, or by continuance of heat, also renders manifest the change of molecular arrangement; and the above method may be employed for detecting molecular differences in conducting liquids having the same chemical composition.

In the class of cases in which the differences of molecular arrangement were the least, and the currents the most feeble, the direction of the currents was the most uniform. This is in accordance with the common truth in science that the smallest phenomena are the most constant.

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THE ELECTRICIAN.

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THE PROGRESS OF TESTING.

It is interesting now and then to cast a glance back at some particular branch of telegraphy in order to observe what advance has been made during the period reviewed. Taking the subject of testing we find that in 1852 Mr. Window, in a paper read before the Institution of Civil Engineers, quotes experiments of Professor Morse, in which the resistance of different lengths of wire was measured by the power of an electro-magnet to lift weights with varying lengths of wire in circuit. During the discussion on this paper Mr. Siemens, in alluding to underground wires, speaks of finding a fault by the deflections of a galvanometer taken at both ends. In the early days of the Electric Telegraph Company no system of testing by measuring the resistance of the circuit was adopted, but when the cables afterwards laid between Orfordness and Holland were made in 1852 and 1853, the deflection on a horizontal galvanometer was noted with one element in circuit as every ten miles of cable were completed and added to the circuit, and from the tables made from these tests faults were located, when the cables broke down, with sufficient accuracy for the repairing operations. It will appear to many of our readers astonishing that such an apparently crude test could be sufficient for the purpose; but, in fact, the method is more accurate than would at first appear. The deflection of a non-astatic horizontal galvanometer, and which has no adjusting magnet, but has only the earth's magnetism to draw the needle towards the zero point, has the great advantage of being very constant as regards the force of current necessary to deflect the needle to a given angle from zero; for any alteration in the magnetism of the needle affects equally both the component forces. Again, in these tests, the deflections being taken with the cable itself actually in circuit, any variation in the conductivity of the copper—and, no doubt, in those days there would be considerable variation, since its conductivity was never measured—was eliminated from the problem. There remained as sources of error the variation in the electromotive force, and this, in a good Daniell, element, is not very great, and, lastly, the effect of temperature on the resistance of the copper. Perhaps, the greatest reason why these tests were, after all, as sufficient for the purpose as those of the present day, is that the greatest source of error, viz., the variable resistance of the end in a broken cable, and which overshadows entirely all the other causes of error, is scarcely any nearer solution now than then, so that the accuracy obtained by the refinements of modern testing are, in most cases of single cable fractures, rendered of little use, owing to this still unknown quantity. In the testing of the Atlantic cable of 1857, although the tests applied were anything but perfect, a continuous test for continuity was maintained, even during the tests for insulation, by means of an insulated battery and galvanometer. Differential galvanometers and resistance coils came into fashion about 1858, and faults in longer cables than the Dutch cables were located with tolerable accuracy, without any previous tabulated deflections with the cable in circuit during manufacture, a unit being obtained by measuring the resistances of a piece of span cable of the same type.

The insulation resistance of the wires was, up to 1859, compared by noting the insulation deflections with a given electromotive force or given galvanometer when the end was insulated, and a rough comparison could thus be established of what was good or bad, but no quantitive measurement was thus obtained.

In 1859 Messrs. Siemens, as electricians to Mr. Newall for the first Red Sea cable, introduced the measurement of the insulation by units of resistance, and also the Wheatstone Bridge as a means of measuring both the copper and insulation resistance. This was a very great advance, and of immense use, as the accurate measurement of the insulation resistance enabled manufacturers to trace the reasons of variation in the insulating properties.

About 1861 attention was drawn by Professor Matthieson and Sir William Thomson to the great variation in the conductivity in different kinds of copper, and this led to the conductivity of the copper being carefully measured by special arrangements of the Wheatstone bridge during the manufacture of the first Persian Gulf cable in 1863, the tests being taken by Messrs. Bright and Clark's assistants at the manufacturer's of the copper wire. But a more important step also dates from this cable. Hitherto the variation in the insulation resistance of the gutta percha, caused by change of temperature, had been a barrier to any accurate comparisons of the insulation resistance. Experiments were, therefore, carried on by that eminent electrician, Mr. J. C. Laws, on the part of Messrs. Bright and Clark, at the Gutta Percha Company's works in Wharf-road, with the view of determining the increment of increase of resistance with decrease of temperature. The wire was immersed in water

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and ice, and the temperature gradually raised, and tests taken at every two degrees from which the now well-known tables were constructed, and all tests reduced to 75 degrees Fahrenheit, this temperature being supposed to be the mean temperature of the water of the Persian Gulf. On these experiments the Thomson reflecting galvanometer was first employed, and on the laying of the cable in 1863 and 1864 the Thomson marine galvanometer was first used. These instruments were, of course, an immense boon, as besides their superior accuracy, sines of the angles had previously to be employed.

With regard to the tests taken on board ship, at first currents sent from shore every few minutes were used for continuity with occasional tests for insulation. Then clocks were adopted ashore first on the repairs of the Hague cables, which put a current on from shore for five minutes, insulated the end for another five minutes, and put to earth for five minutes. The same system, only with longer intervals, and with a speaking instrument in circuit instead of merely putting to earth, was adopted on the Red Sea Expedition of 1859 by Messrs. Siemens. On the Persian Gulf of 1863 and 1864 a different system was planned by Mr. L. Clark and Mr. J. C. Laws. The test for insulation was kept constantly on, the current being reversed on the ship every half hour, and for continuity a condenser was charged from the cable end every five minutes, and discharged, thus giving a slight and sudden deflection to the ship's galvanometer. This operation was done by means of clockwork. If ship wanted to speak to shore they gave two reversals, and if shore wanted to speak to ship they put condenser on and discharged two or three times. By this means ship or shore could intimate to each other that they wished to speak, and to do so the regular speaking instrument had to be connected, thus interrupting the regular tests.

In 1866 a new system was adopted by Mr. Willoughby Smith on the Atlantic Expedition; the cable ashore was connected through a very high resistance and a delicate galvanometer to earth. A constant test for insulation was kept on at ship, but a slight increase or decrease of battery power would give a signal to the shore on the delicate galvanometer. For the shore to speak to ship they could put to earth on the ship side of the high resistance, through a high resistance for a dot and through a less resistance for a dash, so that in the first case the deflection on the ship's galvanometer was increased by a few divisions, and in the second case by twice the number of divisions. Thus, speaking from ship to shore, or *vice versâ*, was possible without any serious interruption to the insulation test.

The testing of a joint by L. Clark's accumulation test was first carried out on the Persian Gulf cable in 1863, and this has been one of the most important improvements, as bad joints have much to answer for. Varley's slides, employed in the insulation tests at sea in the Telegraph Construction Company's ships, date, we believe, from the French Atlantic cable in 1869.

On suspended land lines the use of the tangent galvanometer to take morning insulation readings was introduced by Culley, but at what date we are uncertain, and Schwendler has adopted some improvements in India. Tests for induction capacity became of more importance about the year 1863, when the low inductive capacity of Hooper's core was noticed and published by Sir W. Thomson and Messrs. Bright and Clark. During the last few years the tests for the finding of faults in submarine cables have been improved, but we have mentioned enough to show that our electricians have not been standing still during the last quarter of a century.

CORRESPONDENCE.

WHAT SHALL WE CALL IT?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I know it is difficult for any critic in a short article to review comprehensively all the phases of an important question such as the change of "title" of a learned society. I will therefore, with your permission, call attention to one or two circumstances which have not been sufficiently noticed in the consideration of the circular of the Society of Telegraph Engineers. If the society had to be founded *de novo* there would be but one title that could include the scattered interests the society represents, but it must be remembered the society exists, and is widely known as the "Society of Telegraph Engineers." This may not be the exact name given it by its founders, but it is *the* popular name, the name under which it is designated by the Press, under which its work has been accomplished, and its progress made. Of course we know that "Electrician" is comprehensive enough, yet to many the student of the "applied science" is not an electrician, and there are many members of the society who are neither students of the science of electricity, nor the applications of electricity. Undoubtedly the council of the society, in the deliberations on the change of title, discussed the propriety of calling the society that of "Electricians and of Telegraph Engineers," and good as such title is, it must be confessed that the change is fundamental, and many people would think a new society in opposition to the old had been originated. Logically, the name, if compound, should have as its first part the word indicating the science, and as its second the word indicating its application. As regards the taking into council the opinions of all the members, it seems to me that all criticism on this head is mistimed and out of place. Is not the council elected to represent the members? Is not the power of carrying on the society placed in its hands? If the members of the council have not the confidence of the members of the society how came they there? The suppositition that the council should appeal to members is absurd. It was stated last year that the change of title was under consideration, and if members had any suggestions to make why were they not made? In my opinion criticism should be so directed as to suppose the suggestions have been made, have been duly considered by the council, and the title put upon the circular is the result of a careful, unbiassed opinion on the whole question. Perhaps some few members would like to have the subject of the title discussed at one of the ordinary meetings, would like to hear all and every reason why this wording or that wording has not been adopted. Such a desire implies "a want of confidence" in those you have elected to represent you. If this want of confidence exists to any extent by all means let us have a definite understanding. If confidence in the ability and zeal of those placed at the helm is still held by the majority, let us show it by accepting the decision of those we have elected to decide for us.—Yours, &c., M.S.T.E.

CONTRIBUTIONS TO A PHYSICAL THEORY OF ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Some apology is due to you and to the readers of *The Electrician* for the delay in continuing the papers under the above heading. This has been caused by indisposition, superadded to press of work in other directions. I hope, however, soon to be able to resume this work—some of which is utilisable by those who hold theoretical views different from my own.—Yours, &c., DESMOND G. FITZGERALD.

THE ESSENTIAL NATURE OF ELECTRICITY.—III.

BY J. T. SPRAGUE.

In my last paper, p. 224, I had occasion to remark upon the necessity of distinctly separating hypothesis and fact; but in molecular physics, which we have now to consider, the two are inextricably intermingled. The very existence of atoms and molecules is a matter of hypothesis, because their minuteness puts them beyond our powers of observation; but this hypothesis so perfectly accords with the facts observed in every branch of science, and is, moreover, so supported by the motions testified to by the spectroscope, that we are entitled to regard the existence of matter in the form of the discrete particles called atoms

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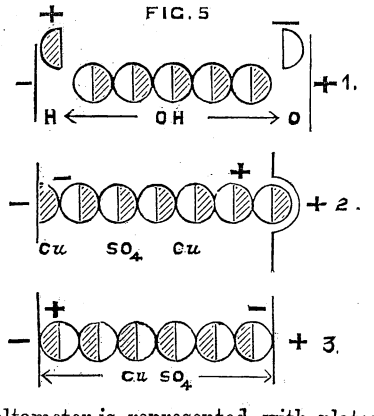
and molecules as so surely established that we may treat it as fact.

The particular nature of these atoms and molecules is not by any means so well established, and our views of their relations have undergone such changes of late years, and remain yet so unsettled that we can only treat them as hypotheses subject to full examination and open to modification. We have, in fact, two widely accepted theories of the nature of atoms : 1, the old view upon which they are of the value or weight of the chemical equivalents ; 2, the new notation, in which the value is governed by the unit volume in the gaseous state and the relation to force, as heat, pressure, &c. There is a great deal to be said for both views ; to the electrician the first is by far the most simple and acceptable, for all the facts of electrolysis are surely related to and simply explained upon the equivalent system. To chemists and physicists in general the new or atomic system commends itself by its more general accordance with the laws of force. But, after all, as in so many other cases, the unprejudiced mind will be apt to conclude that each is true, and neither is the truth ; that they are each the expression of particular classes of natural facts and inter-relations of matter, and that, by and bye, they will both be absorbed into some more general theory ; meanwhile we may use each in turn as it best suits our particular object.

The more we study electric conduction (especially in electrolysis, where its peculiar features are most fully brought out) the more evident it will become that we ought to simplify our ideas by treating it as based upon the actions which occur in a single line of binary molecules such as are employed in Fig. 4, p. 225. This conception underlies Faraday's laws of electrolysis, and is quite analogous to the idea I have employed in my "Electricity" to simplify the principles of conduction in wires :—"We must, in fact, regard the wires, not as single cylinders, but as though they were built up of a series of parallel unit cylinders of definite properties." For the practical unit in wires I took a wire of one thousandth of an inch diameter, a circular "mil" one foot long. From this, when once fixed in the mind, it follows that conducting power must increase as the number of such parallel circuits, that is to say as the sectional area of the wire, or the square of its diameter. Electric resistance (so called) being simply the reciprocal of this conducting power, diminishes in the inverse ratio, and naturally increases directly as the length. Precisely the same ideas apply in the case of electrolysis. The conducting power must evidently vary as the number of separate molecular paths or chains ; it, and therefore its reciprocal (so called resistance), and the work done or energy absorbed in each molecular action (the true resistance) will depend upon the specific properties of each kind of molecule, the affinities within itself and the relations between contiguous molecules.

Now, we are here brought directly in face of our two fundamental facts or expressions, "quantity" and "energy," and Fig. 5 will aid us in studying their relations. I use in it the equivalent system, because it conveys the electrical facts more clearly by constituting each molecule of a single anion and cation, that is to say, as a binary composed of a + and of a — atom or radical. I use water HO, weight 9, and sulphate of copper $AnSO_4$, weight 124·75. On the atomic system water would be H_2O, weight 18, and sulphate of copper $CuSO_4$, weight 249·5.

FIG. 5



In line 1 a voltameter is represented, with plates of platinum breaking up water into oxygen and hydrogen, this being the ultimate result, although the actual reaction with dilute acids or alkalies is somewhat more complicated. We have here, then, a natural unit of "quantity," one molecule of water decomposed, one equivalent of hydrogen given off at the cathode or—plate; this quantity may be any weight, say one grain, or one gramme or decigramme. By connecting *time* with this *quantity* we have a natural unit of current. In my work I have thus used one grain of hydrogen (or equivalent) in ten hours, under the name of the "Chemic," as the unit of current. But let us use what particular system of weight we please, we have a generally applicable natural measure of "electric quantity" in the decomposition of one binary molecule, because the same electric quantity or current passing through a succession of cells containing different sorts of such molecules will break up one in each ; for instance, line 2 represents a decomposition cell containing sulphate of copper. If, then, these two cells shown in lines 1 and 2 were arranged in series, so that the same current were to pass through them, while one grain of hydrogen is released in cell 1, 31·75 grains of copper would be deposited at the corresponding plate in cell 2. In like manner, while the equivalent eight grains of oxygen is set free at the anode in cell 1, the equivalent cation SO_4 (a radical not capable of a separate existence), would combine with the equivalent 31·75 grains of copper, which it would dissolve from the anode of cell 2. Here, then, we have a definite physical representative of a unit of "electricity," that is to say, of a quantitative molecular relation, which is perfectly universal in all the chemical relations of electricity. There are many other molecular relations which can be traced, but their exact quantitative relations are not so easily examined ; hence the great importance of this one in the consideration of the nature of electricity.

The figure, then, shows us two distinct subjects for our consideration. 1. This quantitative result, the breaking up of a molecule, the constituents of which appear at the two plates only. 2. The actions which, though invisible, must take place in the body of liquid interposed between the two plates. Now these actions are two.

1. *Each molecule breaks up*, its constituents separate, and each recombines with its corresponding (or complementary) neighbour ; thus the mass of the liquid is undergoing a succession of decompositions and recompositions.

2. *Each molecule makes a semi-rotation on its axis* for each unit quantity of electricity which it transmits.

These actions are shown in Fig. 4, p. 225, but still more clearly in the present figure. In line 2 we have the chain of six molecules just reconstituted ; we see that in such a case the molecules remain unchanged in the liquid, because the solid anode gives up to the liquid an atom similar to the solid atom which is taken from the liquid at the cathode. We see, then, that the newly constituted chain of molecules must, of necessity be ranged in such order as to present their cations or + radicals (shown white) to the anode or + plate, and their anions (shaded) to the cathode. This will be seen more clearly in line 1, where the escaping radicals just set free evidently must leave the chain ranged in this order. Before another such action and a new decomposition can occur the whole of the molecules constituting the chain must *of necessity* execute a semi-rotation so as to range themselves in the polar order shown line 3. Furthermore, we can see in this Figure the reason why such a rotation should happen, because we see in line 2 that what are called similarly electrified surfaces are presented to each other, and therefore according to the commonly taught maxims they exert a mutual repulsion. It is, however, much more reasonable (seeing that in nature we find many attractive actions, but a repulsive one nowhere) to conceive this action as resulting from the mutual attractions of the + plate upon the — radical then turned from it, and the like action of the — plate upon its corresponding + neighbour. We may go much further, indeed, as will be seen hereafter, and trace the probability that each of these plates exerts this action, not upon its immediate neighbour only, but upon all surrounding molecules, those of other chains as well as its own, and upon all within its own chain, each influencing all its surroundings according to the well-known law of attractions, varying as the squares of the distances. But of this hereafter ; it forms part of the consideration of the *causes* of the motions, while our present subject is the *motions* themselves and their effects.

We have, then, a liquid conducting body across which we know that electricity (quantity), and energy are being transmitted, and we are compelled to conclude that the molecules of this conductor are undergoing the two actions or motions just spoken of. Decomposition cells usually consist of considerable bodies of liquid, but this is not so of any necessity. The intervening liquid may be drawn out into fine wires ; that is to say, it may be contained in fine glass tubes of any length we please, and all the difference will be in the conducting capacity. This difference will be as before stated ; just as with wires, it will be diminished (1) in the ratio of the area, because the number of molecular chains available will, of course, be diminished in that ratio ; it will also be diminished (2) in the ratio of the length, because the number of molecules in each chain (and, therefore, the work to be expended in effecting the molecular actions) will increase in this ratio. This is the same thing as saying that the (so called)

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resistance increases in the inverse ratio of the area (or of the square of the diameter) and as the length; but by considering the conducting capacity we have the reasons presented to us, while, by considering the resistance, these reasons are lost in a mathematical myth. Now, if we take such a drawn-out liquid conductor and put it to the test of experiment, we find that there is not the smallest trace of difference between it and a solid conductor of equal conducting capacity and area; that is to say, the only difference among all classes of conductors is a *difference of specific conductivity*. Liquids have less conducting power than metallic solids, and more than many other solids. But, given *the same conductivity, there is no other difference whatever*. Such a liquid wire may be stretched in a straight line, or it may be coiled up as a helix; it will then have precisely the same powers of producing static induction, precisely the same magnetic actions as a solid wire.

Have we not, then, the right to conclude that in the solid wire there are actions occurring analogous to those occurring in the liquid wire?

We know even that we can extend such a liquid wire for thousands of miles, for what is the return earth circuit but such a wire? Mathematicians are, indeed, fond of giving us another explanation, and talking about the earth being an infinite reservoir. But common sense shows that the analogy I have drawn is perfect, and, as a matter of fact, if the two earth plates differ, if one is zinc and the other copper, the intervening earth acts precisely as do the liquids of a common battery, and will set up a current through the wire exactly corresponding to that produced by a common battery.

THREE MONTHS' EXPERIENCE OF ELECTRIC LIGHTING AT BLACKPOOL.*

Under this heading I propose to place before you some particulars of the mode of laying down, together with the capital cost and the working expenses of the electric light plant erected last year in our town, feeling sure that it will be of interest not only to yourselves, but to the gas world generally, inasmuch as it is the only town in which electricity has been tried to the best advantage, and on a practical working scale.

In the beginning of August last year our town council unanimously agreed to light up the central portion of their extensive promenade, which has a sea frontage of three miles, by means of the electric light, in a manner surpassing anything that had ever been attempted before; this system of lighting to be employed every season during the autumn months, and on days of festivity. The opening day was to be the 18th of September, and I may here say that they have accomplished their object of having created a sensational light.

The committee appointed, together with my father, their gas engineer, they proceeded at once to inspect all the best-known systems, viewing, amongst others, the well-known Thames Embankment lights; but so thoroughly satisfied were they that in all these there was nothing but what some large gas lamps would supersede, that they resolved to strike out the rather bold experiment of having large centres of lighting, and employing four naked lights of 6,000 candle-power on the Promenade, and one on the end of each of the two piers. The area to be illuminated was therefore a quadrangle, 1,000 yards long and 400 yards wide. The four lights on the Promenade are 350 yards apart, and those on the piers about 400 yards from the shore. The whole are placed in plain glass lanterns 60 feet above the level of the roadway. This is necessary with naked lights, so as to remove the strong penetrating power from the eye when approaching the lamps, as well as to better distribute the light between them.

Having briefly described the object desired to be accomplished, I cannot do better than explain the mode of procedure adopted to produce the effect. Arrangements having been come to with Messrs. Siemens, of Charlton, near Woolwich, for the supply of the necessary electric apparatus, and with Messrs. Robey and Co., of Lincoln, for the engines, and the whole of the plant being under the control of the Gas Department, it became part of my duty to superintend its erection, and to see to its working after the contractors had completed.

The site selected as being convenient for the machinery was the Corporation Depôt, situated 400 yards from one end of the Promenade, and 250 yards inland. Here was put up a substantial timber building, 60 feet by 25 feet, and inside, on the ground, was laid a framing, which formed the foundations for the machinery, the interspaces between the timbers being filled in flush with concrete, and then boarded over to prevent dust rising. Upon this were fixed, as they arrived, two portable 16 horse-power engines and boilers, and at the opposite end were the electric machines, of which there were seven, all being driven from a counter-shaft placed between them and the engines. From each of the six machines a distinct wire is led to its own lamp, and one common return wire, so to speak, answers for the whole. You will, no doubt, wonder what the odd machine was for. Well, at first, the whole of the six machines had to perform the duty of producing their own electricity, but that duty is now taken from them by specially devoting a dynamo-electric machine to that purpose solely, and this was found to be better for the lights.

The first difficulty we had to contend with was the laying of the wires inside the 2-in. and 3-in. cast-iron pipes, it having been decided to place them underground, hidden from view. This proved no easy matter, inasmuch as the wire was in 500-yard lengths, and it was desirable to have as few joints as possible. It, therefore, cost as much to put the wires through as it did to make the trenches, so careful had we to be in order not to damage the insulation, and to keep off the water. The weather happened unfortunately to be unfavourable for us, as, a day or two after commencing, a series of high winds set in, with their usual effect at Blackpool of forcing the water over the Promenade, to the amusement of visitors, but to the detriment of our work; for, at every tide, it filled the trenches and pipes with sea water. However, as there was no time to stop, we persevered, and completed the 1,500 yards in the week allowed us, and were ready for the preliminary trial to take place on Saturday, the 13th; but, alas! all our efforts were unavailing, for the insulation of the wires had yielded to the water, and it was quite spoiled for the purpose, so there remained no alternative but to withdraw them. This we commenced on the Friday evening, and drew out the whole and laid them on the arms of the lamp-posts. By the Saturday night we had temporarily connected the wires, and had two of the most commanding lights at work with good effect. By the following Monday morning we had collected together the most suitable poles in the town, and immediately set to work and placed them up telegraph fashion, and secured the wires thereto with iron staples, there being no time to get insulators fixed. During the time the wires were being completed, experiments and trials were going on in the engine-room, and by Thursday, Sept. 18, all was finally ready, and the lights were lit at dusk with remarkable steadiness, considering the drawbacks we had to encounter for want of time.

I may tell you that it was with no small degree of pleasure I beheld, from an elevated position, the lights shedding down their bright white beams on the upturned faces of at least 70,000 persons who had come to Blackpool to witness the grand spectacle—to see the poor gas once for all annihilated. Well, I must say the gas cut a sorry figure when burning in the lamps when the electric lights were lit, of which a good many of you present were eye-witnesses; but it became very useful as the nights grew darker, and one of the new illuminants was suddenly extinguished, for it would have been unsafe to the public to have left all in darkness, which might have occured at any moment. As we got more accustomed to its eccentricities and freaks of going out every now and then, we gained confidence because we found out how to apply the remedy. In nine cases out of ten the cause was the rack holding the carbons getting fast, and a man was usually on the look-out to shake it with the line to the lamp. So frequently did this happen that ultimately the passing public and youths saved us the trouble by merely pulling the line as they went by. Sometimes, however, more serious mishaps would occur, owing to the exposed position of the lights, and to the strong gales of wind and rain. The delicate working parts were affected by corrosion and damp, and in such cases there was no alternative but to take the lamp in for readjustment; so it had to remain extinguished for the night, or if it was a very bad light, it was better policy to shut it off. One would naturally say, why not take out the spare lamp and substitute it for the other? This seems very simple until explained. The reason is this, that owing to all the circuits being of different lengths, and having different resistances, each lamp had to be accurately adjusted, and tried in the test-room, with the current flowing all through the wire. Thus, supposing No. 1 lamp went out, and could not be got to work again; it is 1,400 yards away, and it would be necessary to send two men to lower it, couple the two wires together, bring the lamp back, and set to work adjusting the spare lamp to the circuit, which would require, say, half an hour; then to send it back and hoist it up, the whole occupying 1½ hour, during which the light would be out, and would need another attendant, who would afterwards have nothing to do, and some nights would never be wanted, although he must be always at hand.

The mode of working which we have found to be the most

* A Paper read by Mr. W. Chew before the Manchester Institution of Gas Engineers.

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advantageous is the following:—One engineman and assistant look after the engines and boilers, which require very great attention in their stoking, for a variation of 5lb. pressure of steam will throw all the lights out of order. Another man is kept to oil the machines and keep all going right in that department, as well as to look for any light going out, which in some cases instantly shows itself at the machines, but always at a dial-board, on which all the connections are made, and on which we have suitable tell-tale appliances. The hour for starting work is one o'clock p.m., and then the mode of procedure is as follows:—All three men start out and fix the carbons in the lamps, clean the same, and hoist them up again. To go the whole round occupies 2½ hours if all is well. Occasionally a carbon-holder is burnt away, the lamp having burnt too hard on a windy night, and this the men generally refit with a spare holder they take with them. On these occasions three hours is about the proper time. They next return to the machine-room, clean the engines, and go carefully over the machines and belts, and then all is ready for lighting, which generally lasts five hours. We should have to go round the lamps a second time if we had to light all night; this would entail another staff, and be very expensive. I myself attend almost every evening at the depôt during the period of lighting, to see that all is kept right, and to put in proper order all the lamps brought in, as well as to instruct the man in any repairs and alterations to be made. It is also very requisite to go round two or three times a week to see the carbons fixed in the lamps, and to adjust them a little, and to see that the current is working the right way through the lamp.

Having given you a good idea of the work to be done, I think I could not do better than proceed to give you a few particulars of the cost of all this, and I will put our system in comparison with the others, so that you may see the proportion of the costliness between large lights and the small ones, comparatively speaking—those of the divided current, or Jablochkoff system. The following figures will show the amount of the capital account. Those of Westgate-on-Sea and the Thames Embankment are from the reports of Messrs. Bennett and Valon, and of the Metropolitan Board last May, but to the latter I have added the apparatus which I find necessary to work their plant permanently, and this enhances the capital. Each item that is added is marked with an asterisk (*). It must be noted that the apparatus at Westgate was only temporarily fixed:—

CAPITAL ACCOUNT.

Blackpool.

Six lights = 36,000 candles available.

	£	s.	d.
Two 16 horse-power engines and boiler, with reserved power	598	0	0
Counter-shaft	52	0	0
Coating	13	0	0
Seven machines (Siemens's)	800	0	0
Seven Siemens's lamp and six lanterns	143	0	0
Terminals	12	0	0
Belting	60	0	0
8,800 yards of cable	556	0	0
Posts and poles	40	0	0
Engine-house	200	0	0
Foundations	60	0	0
Gas and water fittings	9	0	0
Strophometer	10	0	0
Velocimeter	2	0	0
Tools	10	0	0
Galvanometer battery and leclanche	5	0	0
Ropes, tackle, stays, &c.	30	0	0
Labour erecting, and sundry bills	200	0	0
Total	£2,800	0	0

Westgate.

Six Lights = 1,182 candles available.

One 10 horse-power engine and boiler	£300	0	0
Two Gramme machines	220	0	0
Six Jablochkoff lamps, complete	60	0	0
Terminals, &c.	2	0	0
Belting	4	0	0
1,200 yards of cable	110	0	0
Six lamp-posts	12	0	0
Engine house	300	0	0
Foundations	10	0	0
Gas and water fittings	9	0	0
Strophometer	10	0	0
Velocimeter	2	0	0
Tools	10	0	0
Galvanometer battery and leclanche	5	0	0
Labour erecting, and sundry bills	46	0	0
Total	£1,100	0	0

Thames Embankment.

Twenty Lights = 4,000 Candles available.

One 20 horse-power engine and boiler, with reserved power	£495	0	0
Counter-shaft	20	0	0*
Two Gramme machines	360	0	0
Twenty Jablochkoff lamps, complete	200	0	0*
Terminals, &c.	5	0	0
Belting	35	0	0
3,900 yards of cable	390	0	0
Twenty lamp-posts	40	0	0*
Engine house	300	0	0*
Foundations	50	0	0*
Gas and water fittings	9	0	0*
Strophometer	10	0	0*
Velocimeter	2	0	0*
Tools	10	0	0*
Galvanometer battery and leclanche	5	0	0*
Labour erecting and sundry bills	69	0	0*
Total	£2,000	0	0

Below I will compare the working expenses we are now at, and those of the others for one night of 5½ hours:—

Blackpool.

36,000 Candle Power.

One engineman	£0	5	0
One assistant	0	3	4
Attendant and supervision	0	7	0
Oil, tallow, turps, &c.	0	1	6
Water for boiler and general use	0	0	6
Gas	0	0	6
Carbon, with waste, 10 feet at 9d.	0	7	6
Fuel, coke, and coal, 13 cwt. per night	0	6	6
Interest at 5 per cent.	0	11	8
Repairs and maintenance, 10 per cent.	1	3	4
	£3	6	10

Westgate.

1,182 Candle Power—Four Hours Lighted.

One engine man	£0	5	0
Attendant and supervision	0	7	0
Oil, tallow, turps., &c.	0	0	5
Water for boiler and general use	0	0	2
Gas	0	0	6*
24 candles at 8d., 16s. 3d., dropped to 2d.	0	4	0
Fuel, coke, and coal	0	6	0
Interest at 5 per cent.	0	4	7*
Repairs and maintenance, 10 per cent.	0	9	2*
Total	£1	16	10

Thames Embankment.

4,000 Candle Power.

One engineman	£0	6	8
One assistant	0	6	8
Two assistants	0	10	0
Oil, tallow, turps, &c.	0	1	7
Water for boiler and general use	0	0	2*
Gas	0	0	6*
20 candles, each lasting 1¼ hour = 80 candles, at 2d. each	0	13	4*
Fuel, coke, and coal	0	4	9
Interest at 5 per cent.	0	8	4*
Repairs and maintenance, 10 per cent.	0	16	8*
Total	3	8	8

Now, it is a very difficult matter to put the proper interest to these tables, inasmuch as the longer the lights are burned the less is the cost per hour; but as I must compute it in some way, so as to arrive at the actual cost, I shall take our own as we intend to use it, or I will give it the benefit of being lighted every night during which our gas-lamps are alight—viz., 240 nights—and allow them to burn from 5 to 5½ hours. Any other deductions you wish can be made accordingly. In the preceding table you will note that we have two engines and boilers, and during the last week we kept the plant going with only one running; therefore, we shall compare favourably with the others in having reserve power, which is far better for working steadily and safely, and I may say it would be very necessary to have other parts of the plant in duplicate if we were working under penalties for not keeping up the illuminating power, and were fined heavily for occasionally leaving part of the town in darkness.

Before closing my paper, I will say a word or two on some of the effects which our lights have produced in different states of the atmosphere, and conclude with a few remarks on electric

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lighting generally as an illuminant for our cities. The four lights as now placed light up the Promenade at Blackpool very well for a length of 1,500 yards, but not evenly, there being a flood of light directly under them, and not so much midway between them, though amply sufficient for any requirement. If there had been six lights on this length, the effect would have been uniform throughout. As comparing the diffusibility of the light under various conditions, the best result I have noticed particularly has been on some nights when I have been able to read the time very readily by my watch at a distance inland of about 1½ mile. This effect, I am of opinion, was caused by the reflection of some passing rain clouds which I noticed hanging about in large masses pretty low in the atmosphere. The same thing has been of particular benefit to some of the fishermen, who have had to go out on the sands about two miles away at night time to take fish, and they have many a time been able to see distinctly. The opposite effects are produced in a dense fog. I have only been able to see the lights at a distance of 100 yards, and I could see at the same distance one of the large 100-candle gas lamps we have fixed in another part of the town, owing to the difference in the colour of the light.

The strong concentrated light of an electric lamp is very bad for the eyesight, and I would not recommend any one having a weakness in that direction to look at them. I myself, as well as the men employed, have had painful experience of the result, although at the time we were unconscious we were being affected. While experimenting with the lamps it is not noticeable, but after leaving the room the effect is severely felt, and if badly affected there will be no sleep for you that night, but you will have to sit up and keep the eyes wide open, and shaded from light, as it is impossible to shut them, so painful are they. This result has been produced, though in a less degree, in the case of a great many who have visited the room to see the mysterious apparatus at work.

The grand idea of the divisibility and distribution of electricity in the same manner as gas or water—viz., having large leading wires or mains running through the principal streets, with small branches to each consumer—has not for a moment been entertained by any of the electricians, though this is the plan the anxious public are waiting for; the reason being that you cannot have a storage for your supply, as with gas, where you create a large reserve, and, charging all your pipes under pressure, leave those who require it to simply turn on an outlet for the supply, and, by the grand old law of gravitation, they get all they want from the stock, while a fresh supply would be making and storing for next day in the gasholders. Not so with electricity. As it is generated, so it must be consumed; for electricity must move in a circle, otherwise it cannot be created, and as it moves it disappears. The same electricity does not move round again; it never passes the starting point, but as it comes it dies, and makes room for more. Now, as it is impossible to store electricity in any appreciable quantities, we see that the object must be to utilise its power as it is being generated; therefore, the greatest difficulty is in the distribution as produced. This will be found a great disadvantage, assuming that a town is to be supplied, for it would mean that the apparatus would have to be constantly going in order to supply light when any consumer might at his option desire to avail himself of it during the day or night. It would be like working a gas-works without holders for storage, with the same disastrous results financially speaking, namely, increased capital, and wear and tear of retorts, plant, and now and then all darkness for a short time in the town, if a sudden draught took place on the mains, owing to a large establishment lighting up without notice. This feature in electric lighting has not as yet shown itself, it being now at the will of the manufacturer of the light when the lamps shall be lighted and put out; but let the consumer have that power left to him, which he will claim as his right if he has to pay the bill, and another difficulty is once more placed in the way of electric lighting for towns.

I am, of course, presuming that there is no difficulty in generating electricity, for it is mere mechanical power that is required. Nothing is used in its manufacture, and, consequently, there is no end to its source. This leads me to the electric lighting systems of the present day, which are nearly all alike in their working, as regards divided lights. The plan adopted is to put from half a dozen up to, say, 20 lights on one circuit—that is to say, one machine has 20 lights put on its wire from leaving the machine to coming back. The distance may be no object, so long as your wire has conducting power sufficient; but here again you are met with a difficulty, otherwise you would increase the number of lamps indefinitely; that is to say, the limits of the power of the machine are soon reached, and the more breaks or resistances you put on the circuit, so each of the lights is less in proportion, for the law of the flow of electricity is inversely as the resistance. Thus, let us suppose the current is represented by 100; now add to the outside circuit a resistance of one lamp equal to the internal resistance of the machine, which is about the best result of the Siemens machines, and you have doubled the resistance to the current; therefore, the total current is reduced to 50, of which the outside circuit has 25 available; that is to say, double the resistance, and the current is halved; treble the resistance, and the current is one-third, and so on. Therefore, you will see how quickly the lights are reduced in power, and how soon the maximum is reached, so that you could not have small lights so economical as large ones. The same is the case with lamps burning by incandescence; you all know that it is only the resistance to the current-flow that converts electricity into heat.

I really cannot see the cause for gas directors becoming alarmed lest they should be driven out of the field for lighting our houses, for I am afraid that electricity, with its delicate working parts and complicated automatic cut-off arrangements—all which are claimed to be simple in action, but which I am certain would soon get out of order if left to take care of themselves in any ordinary house—I am afraid, I say, that the cut-off arrangements now in operation would be apt occasionally, under ordinary usage, to cut off all the supply on the circuits instead of that to a single house. For public squares, large halls, and for lighting the main thoroughfares of large towns, where more light is wanted than is now thought necessary by most local authorities, there, I say, gas and electricity will come into competition; but I am of opinion that our main thoroughfares are well illuminated during business hours by the shop lights almost without the gas in the street-lamps; so that to employ electricity on a large scale would be a waste of money, just as much as lamps of 200 candle-power being placed every 60 yards or so apart. After business hours there is, comparatively speaking, not anybody out of doors, and gas-lamps are ample for the purpose of giving light. The scope which electricity has is necessarily very limited, there not being so very many large spaces that will need to be lighted up so brightly as to justify recourse being had to it in preference to gas. There is a larger field open for it in the transmission of motive power, in which electricians may reap more remunerative employment for their labours if they will accomplish their grand idea of utilising the tides, and the Falls of Niagara, in supplanting the present method of supplying motive power for the great industries of the world.

EXPERIMENTAL DETERMINATION OF THE ELECTROMOTIVE FORCE OF THE GRAMME MAGNETO-ELECTRIC MACHINE AT DIFFERENT SPEEDS.*

BY PROFESSOR TAIT, F.R.S.

The following measurements were made by means of a Gramme machine, recently procured for the University. I desired to make use of it not only for electric light but for electrolysis, the exciting of electro-magnets, and various other purposes for which we have hitherto used from 4 to 40 or so Bunsen cells. I therefore arranged the driving-gear so that with the same motor (a 3½ h.-p. gas-engine) it was easy to use either of three speeds. These are, approximately, 800,533, and 320 turns per minute. The electromotive force varies, of course, not only with the speed but with the resistance of the whole circuit, falling off at first rapidly and then more slowly for any one speed as the resistance is increased. As I had no means of measuring the speed directly, I was somewhat puzzled at first to find the electromotive force at any one speed rise to a maximum, and then rapidly fall off as the whole resistance was gradually diminished. But I soon found that this was due in great part to the slipping of the driving-belts (though they were tight), whenever the intensity of the current exceeded a certain amount. A liberal use of rosin almost removed this anomaly, though there is reason to believe there is still considerable slipping. The following table gives the average of a number of experiments which accord fairly with one another. The resistance of the conductor of the Gramme machine is about 1·16 B.A. units. For the added resistance I used coils of stout covered copper wire which were in the laboratory, having resistances 0·054, 1·844, and 3·63 respectively. The first was always in circuit, and a portion of it, of resistance 0·0015, was introduced into the circuit of a galvanometer having a resistance 23. The deflections of the galvanometer were observed with the first coil alone in the circuit of the Gramme, then with the addition of the second or third, and finally with all the coils.

The explosions in the gas engine occur only at every *second* stroke of the piston. This and other causes render the driving

* Proceedings of the Royal Society of Edinburgh.

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power not absolutely steady, but the *average* deflection of the galvanometer was very easily observed.

From the graphic representation of the results the following numbers were taken :—

Nominal Speed.	Whole Resistance.	Electromotive Force in Terms of a Bunsen Cell.
800	1·5	38
... .	3	38
... .	4·5	36
... .	6	31
533	1·5	24
... .	3	23
... .	4·5	17·5
... .	6	9
320	1·5	1·3
... .	3	·5
... .	4·5	2·5
... .	6	2

Next, instead of the second or third coils above mentioned, a Duboscq lamp was included in the circuit, the other arrangements being as before, and the speed being 800 nominal. The deflection corresponds to an electromotive force of about 39 Bunsen cells, and a resistance of 2·66. As the lamp itself was sometimes found to have a resistance of as much as 0·6, and as the carbons have a resistance of from 0·115 to 0·045, per 4 inches, it appears that, approximately, the resistance of the electric arc, under these conditions, is at least 0·8.

Subsequent experiments, in which the lamp was not used, gave resistances varying from 0·75 to 1·2, according to the length of the arc, and when a little sodium was introduced it fell to 0·25. These estimates, of course, include the effect due to heating and pointing the carbons.

The want of accurate speed determinations, of course, deprives the results of scientific value, but they are very useful as an expression of the electromotive force practically to be obtained from the Gramme machine under different circumstances of its ordinary working—showing, as they do, what adjustments to make for the purposes of a particular experiment.

The very rapid increase of electromotive force with diminished resistance at the lowest speed, seems to show that the speed is very considerably overrated when stated as 800 or 533, with the resistance between 1 and 2 B A units. I hope soon to have the means of accurately measuring the speed realised, and shall then repeat these experiments for a scientific and not a mere practical purpose.

NEW PATENTS, 1880.

1,081. TELEPHONIC APPARATUS.—*F. H. W. Higgins.*

1,136. MAGNETO-ELECTRIC MACHINE.—(*A communication*).—*F. H. Johnson.*

1,151. MICRO-TELEPHONE.—(*A communication*).—*R. H. Courtenay.*

1,178. DYNAMO-ELECTRIC MACHINE.—*F. Perry.*

1,184. INSULATING TELEGRAPH WIRES.—(*A communication.*)—*F. T. King.*

1,212. ELECTRICAL FIRE ALARMS.—(*A communication.*)—*C. E. Spagnoletti.*

1,234. GALVANIC BATTERIES.—(*A communication*).—*A. M. Clark.*

1,244. ELECTRO-MAGNETIC MOTORS.—(*A communication.*)—*F. H. Johnson.*

1,259. ELECTRO-MAGNETIC MOTORS.—(*A communication*).—*F. H. Johnson.*

1,286. TELEPHONES.—(*A communication*).—*F. H. Johnson.*

ABSTRACT OF PATENT.

1,049. *Charles Groombridge, Paternoster-row, London.*

Improvements in magneto-electric brakes and in the arrangement of the same, applicable to railways, trams, tramcars, carriages, and other vehicles; also to retarding the speed of or stopping machinery in motion, and for controlling and arresting the recoil of heavy guns or ordnance.

THE ANGLO-AMERICAN COMPANY.—We are informed that the 1873 cable of this company is broken a short distance from the Irish coast, and that the s.s. Scotia belonging to the Telegraph Construction and Maintenance Company has been sent to repair the fault. We hope in a few days to notify this as having been successfully accomplished.

TELEGRAPH SHARE LIST.

Companies.	Closing Prices April 7.		Business Done Week Ending April 7. Highest.	Lowest.
Anglo-American Ordinary...x d April 1	59¾,	60¼	60⅜	59⅛
Do. "B" .....x d April 1	88¾,	⅜	89	87⅞
Do. "A"	33¾,	4¼	34⅜	33½
Brazilian.....x d April 1	7⅞,	⅞	8	7⅞
Cuba	9¾,	10¼	10⅛	9⅝
Do. Ten per Cent. Pref.	16,	⅛	—	—
Direct Spanish	2,	⅛	—	—
Do. Ten per Cent. Preference	10½,	11	10½	10½
Direct United States	11⅛,	⅜	11⅜	11
Eastern.....	9 1-16,	3-16	9 3-16	9 1-16
Do. Six per Cent. Debenture	103,	6	—	—
Do. Five per Cent. do.	100,	2	102	101½
Do. Six per Cent. Preference.....	12⅛,	¼	12⅜	12¼
Eastern Extension	8 15-16,	9 1-16	9 1-16	8 15-16
Do. Six per Cent. Deb.....	105,	8	—	—
German Union	8½,	9	9	8¾
Globe Telegraph and Trust	5 11-16,	13-16	5 13-16	5⅝
Do. Six per Cent. Preference.....	11⅛,	⅝	11⅛	11⅛
Great Northern.....	9⅝,	¾	9 11-16	9⅝
Indo-European.....x d April 1	24,	5	24	24
Mediterranean Extension	3¼,	¾	3½	3¼
Do. Eight per Cent. Preference.....	10½,	11½	—	—
Reuter's	10,	11	—	—
Submarine	233,	8	—	—
West India and Panama	1 11-16,	13-16	1 13-16.....	1 11-16
Do. Six per Cent. Preference.....	7¾,	8	8	7 11-16
Western and Brazilian	7⅛,	¼	7¼	7⅛
West. Union Seven per Ct. 1st Mt.....	120,	5	—	—
Do. Six per Ct. Sterg.	102,	4	—	—

TRAFFIC RECEIPTS FOR MARCH, 1880.

Companies.	March 1880.	March 1879.	Incrse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company.....	—	—	—	—
Cuba Submarine Company.....	3,500 estd.	3,256	244	—
Direct Spanish Telegraph Company	—	—	—	—
Direct United States Telegraph Company ...	—	—	—	—
Eastern Telegraph Company	43,374	41,225	2,149	—
Eastern Extension Telegraph Company	26,425	26,185	240	—
Great Northern Telegraph Company	16,440	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company..	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—
West Coast of America Telegraph Company.	—	—	—	—

ADDRESSES.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

PETER BROTHERHOOD, Engineer, 56 and 53, COMPTON-STREET, GOSWELL-ROAD, E.C.
Specialities—Patent 3-Cylinder Engines (Silver Medal, Paris), as used by Siemens, Gramme, and Wilde for driving Electric Machines.

RANSOMES, SIMS, and HEAD, Orwell Works, IPSWICH.
Specialities—Portable and Stationary Engines, fitted with patent governors, as tried in the electric lighting experiments on the Thames Embankment.

ABBOTT and Co., NEWARK-ON-TRENT.
Specialities—The "Standard Size" Vertical Cross Tube Boilers. Illustrated catalogue, giving every detail of a variety of Boilers 2s. 6d., post free.

CARBON ELECTRODES COMPANY. Works: 39, COMMERCIAL-ROAD, EAST.
Specialities—Carbon Rods of all sizes for Electric Lighting. Also, Plates and all other Moulded Carbon Goods. List of prices on application.

M. THEILER & SONS, Telegraph Instrument Manufacturers, 86, CANONBURY-ROAD, N. Works: ALWYNE-LANE, N.
Specialities—Morses, Polarised Relays, Saunders' Curb Keys, Type Printers, Recording Sounders, Duplex Apparatus (Theiler's Patent).

HOOPER'S TELEGRAPH and INDIA RUBBER WORKS, MITCHAM and MILLWALL DOCKS.
Contractors for the Manufacture and Laying of Submarine Telegraph and Torpedo Cables. Manufacturers of Hooper's celebrated Insulated Core. Printed reports on application. Offices: 31, LOMBARD STREET, LONDON, E.C.

THE BRITISH ELECTRIC LIGHT COMPANY (Limited), 41, PARLIAMENT-STREET, WESTMINSTER, and 17, WATER-STREET, LIVERPOOL.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

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SLIP

MILWAUKEE.—There are sixty telephones in operation now in Milwaukee.

NEW ZEALAND.—The cable manufactured by the Telegraph Construction and Maintenance Company was successfully laid in Cook's Strait on Feb. 12.

SOUTH AFRICA.—A telegraph line, says *The Times* correspondent, is to be erected from Alural North to Masein, the official capital of Basutoland.

MASSACHUSETTS.—Governor Long, of Massachusetts, has signed a bill chartering the American Telephone Company, with a capital of 10,000,000 dollars.

CHICAGO.—Mr. C. C. Haskins, whom so many of us met at the late Paris Exhibition, has contributed an elaborate paper on the voltaic pencil of M. Billet to the Chicago Electrical Society.

THE RONALDS CATALOGUE.—We understand that the last portion of this catalogue is in the printer's hands, and it is hoped that the volume will be ready for issue in a very short time.

PIONEERS.—Some of the best known men in the telegraph work in America have suggested a re-union of all those men who were in the telegraph service twenty years ago, and who may thus be called veterans.

THE SUN ELECTRIC LIGHT COMPANY.—The No. 1 Workshop Lamp of this company has been, since Monday last, on exhibition at the Agricultural Hall, Islington, and its working has been very satisfactory.

THE BAHAMAS.—It is stated that there is a standing offer on the part of the Bahama Legislature of 10,000 dollars a year for ten years to any company that will lay a cable between Nassau and the United States.

THE 1873 ANGLO-AMERICAN CABLE.—We understand that the s.s. Scotia had on Wednesday safely grappled the cable, and spoken to shore. Thus, in all probability, before these lines are read, the fault will be repaired.

A DESERVED HONOUR.—Mr. James Sieveright, general manager of the telegraph between the Cape of Good Hope and Natal, has been gazetted to the most distinguished Order of St. Michael and St. George for services rendered in South Africa.

DENVER.—Judge Hallett, of the United States Court at Denver, Col., on the 30th ult., issued an order restoring to the Western Union Telegraph Company the control of their wires on the Colorado Central Railroad, extending from Denver to Cheyenne, Wyoming Territory, and the company has taken possession of them.

KING'S COLLEGE.—We understand that Professor W. G. Adams, F.R.S., will give a course of lectures during the ensuing term on "Electrical Testing as Applied to Telegraphy." The lectures will be given on Fridays, commencing 23rd inst. The practical work will take place on Tuesdays. Students may attend one or both classes.

AFGHANISTAN.—The following paragraph occurs in General Roberts's despatch:—"P. S. V. Luke, Esq., C.I.E., and H. A. Kirke, Esq., of the Government Telegraph Department, have worked well, and assisted me greatly by rapidly constructing a telegraph line which placed head-quarters in direct communication with the sectional commands."

SHEFFIELD TELEPHONE EXCHANGE.—We understand that the Sheffield Telephone Exchange Company intend applying to the Corporation for permission to fix in the immediate vicinity of one of the central cab stands a small signal box, so that subscribers may be able to call a cab or a hansom at any moment, either from their place of business or their residence.

THE NEW FRENCH ATLANTIC CABLE. — The steamer Pouyer Quertier has been engaged laying the Brest section of the French Atlantic cable. She left Brest on Saturday, and laid the greater portion of the cable by Tuesday. She next proceeded to Porthcurnow, near the Logan Rock, to lay the shore end, proceeding thence to the spot where the cable was buoyed.

EXPORTS DURING FEBRUARY.—The value of telegraphic wires and apparatus connected with telegraphy exported during March, 1880, is stated at £167,564, that during February, 1880, is stated at £54,302, whilst the value of that exported in January was £31,813; the total value for the three months being £253,679, as against £100,604 during the corresponding period of last year.

ELECTRO-METALLURGY.—This process has been applied to the making of statues, the method having been successfully inaugurated by the reproduction of a large clay model in bronze by the electrotyping process, instead of the usual one of casting. This statement is warranted by the announcement that the Electro-Metallurgical Company of Brussels has just completed a colossal statue in bronze of Jan Van Eyck, the great painter, by the system of galvanic deposition.

THE TELEPHONE.—The Edison telephone is in full operation in Paris, the exchange there numbering over 350 subscribers. The carbon transmitter and Phelps receiver are employed. The lines are under the management of the State, and a closed circuit is employed in order to avoid induction currents. Experiments up to distances of 140 miles have been made with success. Trial of the telephone is also being made at the Carberry Mine, near Inveresk, in Scotland.

TELEGRAPHING THE RESULT OF THE MIDLOTHIAN ELECTION.—Great activity prevailed at the General Post Office as soon as the result of the poll had been declared. The telegraph department was immediately besieged by people eager to despatch the news to friends in different parts of the country. This extra bustle had, of course, been anticipated and provided for; and in the course of the evening close upon 2,000 private telegrams were despatched with remarkable facility and expedition.

ELECTRIC LIGHTING.—The Victoria Docks and Holyhead Harbour are to be lighted by electricity. The Royal Navy is adopting Brush's light. Siemens' light has been introduced into the Siam Dispensary, Bangkok, as a rival to Jablochkoff's. South Kensington Museum is also, we hear, to be lighted by the Brush system. The arrival of spring has brought with it a discontinuance of Siemens' light in the reading room of the British Museum until next autumn. The authorities regard it as a good success.

JAMAICA TELEGRAPHS.—Since the purchase of the Jamaica Railway by the Colonial Government the service has been improved, and though large sums of money have been expended on repairs, the receipts have exceeded the expenditure. The line of telegraph has been completed to Montegno Bay on the north-west, and to Port Antonio on the north-east, and it is intended to complete this circuit by a line from Montegno Bay by Savanna-la-Mar and Black River to Spanish Town, and from Port Antonio by Manchioneal and Port Morant to Kingston.

MENDELEJEFF'S PERIODIC LAW AND THE MAGNETIC PROPERTIES OF THE ELEMENTS.—M. T. Carnelly says:—"Those elements which belong to the even series of Mendelejeff's classification of the elements ('Ann. Chem. Pharm. Suppl.,'

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8,133; Watt's 'Dictionary of Chemistry,' Sec. Supp.), are always paramagnetic, whereas those which belong to odd series are always diamagnetic. This rule holds good with all the thirty-eight elements to which it can at present be applied. In the case of the odd members of the same group, the diamagnetism increases with the atomic weight."

THE ANGLO-AMERICAN COMPANY.—In reply to a question from the president of the Western Union Telegraph Company the general manager of the Anglo-American Company is stated to have said that he is now negotiating the contract for two cables, one from Valentia to Heart's Content, with a new form of outer covering for its better protection in deep sea; and the second from Placentia to Sydney, touching at St. Pierre, containing at least three conducting wires, with an exceptionally heavy outer covering, weighing seven tons per knot, and the shore ends of a heavier type.

CABLE CODES.—According to the *New York Journal of Commerce*, Mr. John C. Hartfield, the well-known maker of cable codes, has prepared an entirely new and improved code, which will be issued early in the present month. It will contain 60,000 selected words, each of which will be at least two letters different from any other, a feature that has been much appreciated by the business public in Mr. Hartfield's former publications. The work is being published under the patronage of the leading bankers and merchants of this city, Boston, and Philadelphia, and the author is confident that it will be found to be the most complete, safe, and economical cable code that has ever been published.

THE TELEPHONE IN COAL PITS.—On the invitation of Lord Elphinstone about 40 engineers and others interested in mining operations assembled a few days since at Carberry coal pit, near Edinburgh, to witness a telephone experiment by which persons in collieries can communicate with those on the surface. The experiment was a complete success, and showed how advantageous the telephone might be not only in connection with ordinary pit operations but also in cases of accidents. The apparatus was explained by Mr. Wollaston, of the General Telephone Agency Company, and the party were sumptuously entertained at luncheon in the pit by Lord Elphinstone.

THE APPLICATION OF ELECTRICITY TO MILLING PURPOSES.—A public exhibition was given to New Haven on March 13, of an electric middlings purifier, the joint invention of two young men of that city. The working of the device is said to have been highly promising. Over the wire bolting cloths is placed a bank of hard rubber cylinders, which are slowly revolved against strips of sheep skin and thus electrified. To these rollers the light bran is attracted, to be mechanically brushed into a proper receptacle. This substitution of electric attraction for the air blast in separating bran from flour is said to lessen the waste, while it obviates the necessity of doing the work in a closed chamber and the risk of explosions.

IMPENDING REBELLION OF NICKEL-PLATERS.—There has been for some time past a feeling of uneasiness among nickel-platers working as licensees under the Adams patent, which will probably soon culminate in open defiance of the demands of the United Nickel Company. The licences granted by this company expire April 1, and there will, we understand, be a general refusal to renew. The nickel-platers have long complained that the royalties exacted by the owners of the Adams patent were exorbitant as compared to the cost of depositing a coating of nickel. The reason that so many of them weakened in their previous resistance to the claims of the United Nickel Company was because they had been plating for several years with a double sulphide or chloride of nickel and ammonia, which processes were declared infringements of Dr. Adams's patent. Now, however, they have settled for past infringements, and claim that the conditions of the case are entirely changed. New processes have been discovered which enable them to plate with an acid solution, and as Dr. Adams claimed that this could not be accomplished, they consider these processes as new discoveries not in any way covered by the Adams patent. The decisions in suits now pending before the courts are, therefore, anxiously awaited by both sides.—*Iron Age.*

THE FIRST ENGLISH ELECTRICAL PATENT.—The pioneer electric patent for the United Kingdom is No. 1,318, dated 1782, for "Electrical Machines" and taken out in the name of Edward Nairne. The specification begins "To all to whom these presents shall come, I, Edward Nairne of the Parish of Saint Michael's, Cornhill, in the City of London, optician, send greeting Whereas his most excellent majesty King George the Third by his Royal Letters Patent under the Seal of Great Britain, bearing date at Westminster, the Fifth day of February in the twenty-second year of his reign, did give and grant unto me, that I, the said Edward Nairne, my executors, administrators, and assigns, should at any time agree with and no others, from time to time, and at all times hereafter during the terms of years therein expressed, should and lawfully might make, use, exercise, and vend within that part of his kingdom of Great Britain called England, his dominion of Wales, and town of Berwick-upon-Tweed, my 'new invented and most useful improvement in the common electrical machine (which I call the insulated medical electrical machine), by insulating the whole in a particular manner, and constructing the conductors so that either shocks or sparks may be received from them.'" The specification can be purchased for the sum of 3d. at the office for the sale of such papers in Cursitor-street, Chancery-lane.

THE PHYSICAL SOCIETY.—In our report of the last meeting of the Physical Society, published in the present number, there will be found two items of special interest to electricians, one relating to contact electricity as modified by electrolysis, and the other to the action of a rotating cylinder of iron on a balanced magnetic needle in its neighbourhood. It is to the experimental facts obtained by Professor Ayrton in conjunction with Professor Perry, and to his clear insight and exposition, that we are indebted for the light shed upon Professor Guthrie's two experiments at the meeting in question. In the case of the frictional experiment he showed that the fact of glass being an electrolyte produced a negative charge on flannel rubbed with it, although flannel is + to ebonite and ebonite in turn is + to glass. The more interesting experiment of the two was, however, that with the rotating iron cylinder. It does not, of course, follow that, though Professor Ayrton finds the mere rotation of the iron cylinder to move the needle in one direction or the other according to the direction of rotation, the presence of a parallel current does not influence the result. Professor Guthrie has yet to see whether it does or not; at the meeting he had not time to determine it. Perhaps it will be found that reversing the current reverses the deflection also; and, indeed, this seemed to be the case in a hasty trial made before the meeting broke up.

AN ELECTRIC PENDULUM.—Many attempts have been made to produce an electric pendulum which would work with the same battery power, and without the use of relays, as do ordinary electric bells, and a very simple arrangement, in which all working parts are concentrated into one moving point, has been designed and for some time manufactured by

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Messrs. J. T. Gent and Co., electricians, Leicester. This pendulum consists of an armature, from which the lob or indicating portion is suspended, the whole being hung upon a sharp steel edge, so as to reduce the friction of swinging to the lowest point. It is so balanced that a current of electricity passing through the coils placed behind the armature sufficient to liberate an ordinary indicating tablet, is ample to draw the armature of the pendulum over, and give it a swinging motion, which continues for two or three minutes. The advantages claimed for these pendulums over any other system of calling attention lie in the fact that they do not need the replacement of the signals, while the swinging pendulum is more likely to arrest attention where the bell has not been heard; moreover, the wearing parts are not likely to get out of order, the battery power is kept up, and there is no reason why the pendulum should not keep in working order indefinitely. The same firm have arranged a similar system for air-tubes, the pendulums forming the signals for their well-known electro-pneumatic house-bells, of which Messrs. Gent and Co. are the patentees.—*Ironmonger.*

Electric Discharge of the Chloride of Silver Battery.—By a series of experiments on the discharge in air, hydrogen, and carbonic anhydride, details of which are given, the authors have established that there is a minimum pressure for each gas corresponding with a minimum resistance to the passage of the discharge, but if the pressure be diminished beyond this minimum the resistance increases with extreme rapidity. Although there appears to be no condensation or expansion of the gaseous medium in the neighbourhood of the electrodes, the discharge is accompanied by a sudden expansion of the gas, which, however, does not seem to be due merely to heating, as it lasts the whole time of the discharge, and ceases instantaneously with it. The relation which exists between the pressure and the difference of potential necessary to produce discharge between two plane surfaces at a constant distance may be represented by a hyperbolic curve taking the pressures as abscissæ, and the numbers of elements as ordinates. It is the same for the difference of potential and the distance of disruptive discharge when the pressure is constant. The resistance to the discharge between two plates varies as the number of interposed molecules. The law is the same for points. The authors have previously shown that for a constant pressure equal to that of the atmosphere the potential varies as the square root of the distance. With a constant pile of 11,000 elements the distance at which disruptive discharge takes place varies inversely from 1 to 15 mm. The electric arc and the stratified discharge in a vacuum appear to be modifications of the same phenomenon.

A Telegraphic Fraud out West.—There was a mining case being tried in Virginia City, Nevada, wherein the title to a mine valued at fifty million dollars was in dispute. Now, the future market value in San Francisco of the stock of the mine in litigation depended altogether upon which of the claimants won the suit. If the prosecution won, the stock would fall; if the defendant won, it would rise. If one of the "mining sharps" in San Francisco could obtain reliable information of the final decision of the suit in Virginia City a few hours in advance of any others, there would be "millions in it." Abe Parker—that is not his proper name—the telegraph operator referred to, agreed to furnish one of the leading stock brokers of San Francisco, the desired information for a share in the spoils. Abe's plan was satisfactory and his proposition accepted. Abe supplied himself with a telegraph instrument, some office wire and blank paper, dressed himself like a "prospecter," and started for the mountains. He located in a lonely, out-of-the-way place about midway between Virginia City and San Francisco, in a deserted sheep-herder's cabin in near proximity to the telegraph line. At that time there was but one line between the two cities. Abe ran a fine wire down on two sides of a telegraph pole and into his cabin, arranged his ground wire, set up his instrument, and was ready for business. His idea was to watch the development of the trial by the despatches that were constantly passing over the wire about it, and when it finally culminated, to attach his ground wire—which would not be felt, being about equi-distant between the two cities—receive the messages from Virginia City that would be sent to parties in San Francisco announcing the decision of the trial, as if he were the San Francisco operator. Then he would turn about and send the important information to *his* broker, successfully withholding it from the others. This Abe accomplished, and was rewarded for his shrewdness—you may call it rascality if you like—by the handsome little fortune of two hundred thousand dollars in gold coin.—*From Sam Johnson.*

Phosphorescence Produced by Electrical Discharges.—Most of the platinocyanides, according to the abstract of a paper by E. Wiedemann on this subject, in the *Chem. Soc. Jnl.*, exhibit fluorescence under the influence of electrical discharges, but the fluorescence is dichroïc only as the result of a partial decomposition. Dichroïsm is induced in barium platino-cyanide without any electrical action by placing the salt in a vacuum for a time. The author attributes this effect to the loss of water, by which loss the optical differences of the several directions in the crystals are more strongly brought out. That dichroïsm is so much more quickly developed in the salt when it is subjected to electrical discharges, he explains by the warming of the crystals by the discharge. The superficial parts of the crystals thus losing their water become dichroïc, whilst the deeper-lying parts fluoresce under the influence of the electric discharge. These experiments were suggested by a research of Crookes's, from whose view of the cause of the phenomena, however, the author dissents. Instead of a stream of projected molecules, we have here, the author contends, to do with electrical disturbances or waves, communicating their motion to either of the solids in which vibrations are thus set up, that appear partly as heat, partly as light. A striking proof of the incorrectness of Crookes's theory is an experiment in which the positive current of a Holtz machine is passed through a discharged tube, made with thick glass, in such a manner that it may be diverted within the tube by the finger. A feeble phosphorescence then appears in the inside of the tube, but on the outside a very bright green light is seen. Closely connected with this phenomenon is that which appears when a spherical positive electrode is used within a glass globe, and a collecting point touches the external surface of the globe. On the opposite part of the globe is seen a well-defined shadow of the electrode, surrounded by a circle of beautiful green rays. The starting point for a theory of these phenomena is supplied in Maxwell's equations ("Wied. Galv.," p. 1,226). An electrical discharge effected by the motion of material particles is out of the question, as the velocity of electricity in gases is immensely greater than that of any molecular motion whatever. The reflection of the negative discharge from surfaces on which it impinges is likewise in accordance with Maxwell's theory, if we attribute to the waves of electric polarisation sufficient energy; and that they do in fact possess this may be inferred from their melting the glass upon which they strike.

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CORRESPONDENCE.

WHAT SHALL WE CALL IT?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: If your correspondent, "M.S.T.E.," is right in regarding all criticism of the action of the Council mistimed and out of place, then surely the Council is wrong in asking the members to give any expression of opinion at all. They are however invited to say yes or no; and the invitation is calculated to draw forth an inevitable yes. The unreality of the proceeding is, for one thing, what may be reasonably objected to; and I know several members who moreover agree with your article in taking exception not only to the mode of procedure but to the choice of title. They suspect, too, that the matter could not have received full and careful consideration, or the result would not have been a circular framed in such illogical terms. If the issuing of a circular was necessary, the case might have been put thus,—Such and such reasons have determined us in choosing a new name, *if* new name we are to have; if you accept it, say Yes; if you prefer no change, say No. But what the Council really say is,—We propose to make ourselves A.B., therefore we ask you whether you will or will not be called B.A.;—a request which is the more incomprehensible, because in the particular case we are considering, A happens to include B.

I think that their reasons might have been frankly stated. It is possible that the loan of the room belonging to an Institution peculiarly Engineering may be one of them. I cannot believe that the identity of the Society could have been another. That would have been met by "Late Society of Telegraph Engineers" being bracketed under the new title for a year or so. The other reasons mentioned by "M.S.T.E." deserve more careful attention, but on examination they really go for nothing. We are afraid, it seems, to presume to call ourselves Electricians. This would be modest if we had not already called ourselves Engineers. Some of us are Electricians, a few are Telegraph Engineers, some are both, while the major portion are Electricians in a liberal sense but Engineers in no sense whatsoever. Telegraph Engineers, in the strict meaning of the term, are and always must be very few in number; but, taking a wider signification of the term, it is almost inconceivable that any person laying claim to the title Telegraph Engineer has not a right also to be regarded first as an Electrician. In fact, if his operations are not based on electrical knowledge, he is a Civil Engineer, and not a Telegraph Engineer at all. Telegraph Engineering implies electrical knowledge, and although we may respect the scruple we can hardly follow the logic of persons who were content to be called Telegraph Engineers, but now shrink from being designated Electricians. For my part I think THE ELECTRICAL SOCIETY would have been the most comprehensive and handiest title; but if we must have a double-barrelled title, courtesy, logic, and expediency point to ELECTRICIANS having the first place.

ANOTHER MEMBER.

11th April, 1880.

THE MAGNETISATION OF INDUCTORS BY ALTERNATING CURRENTS. SUPPRESSION OF THE MACHINE FOR EXCITING DYNAMO-ELECTRIC MACHINES GIVING ALTERNATING CURRENTS.

BY M. A. DE MERITENS.

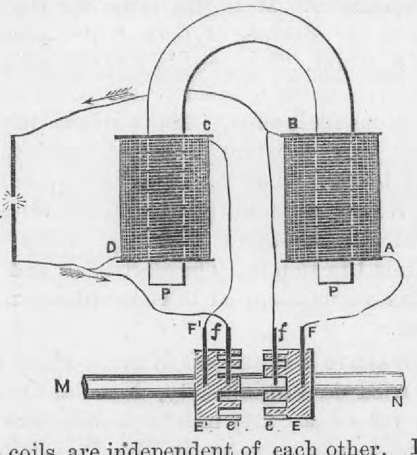
(Translation.)

Are magneto-electric machines preferable to dynamo-electric machines for the regular and economical production of light? This question, which was long ago propounded, has not yet received a solution. It is in fact very difficult to give a satisfactory answer to it. Each of these types of machine has its advantages and its drawbacks. The magneto-electric machine has on its side the invariable magnetism of its inductors. If the velocity of the coils under induction is augmented or diminished, only the tension of the current* is modified; the quantity remains very nearly the same. As there is no solution of continuity in the collectors, the voltaic arc increases or diminishes with the movement; but no danger of extinction is to be feared. It is this consideration which has caused a preference to be given to magneto-electric machines for the illumination of lighthouses. The mechanical force needed to set these machines in movement is less than that which is requisite for dynamo-electric machines. As the former are provided with inductors in which the magnetism is permanent, they effect a saving of all the work absorbed in the magnetisation of the inductors in their rivals. But, on the other hand, the magneto-electric generators are very bulky. Their cost price is considerable, and this consideration contributes in great measure to restrict their use for industrial purposes.

The dynamo-electric machines are smaller in dimension, supply a larger quantity of electricity and are cheaper. But the smallest change in the velocity of the motor which drives them alters the conditions and the value of the light. The mechanical force necessary to produce a given quantity of light is greater. It is requisite to have two machines in order to obtain the alternating current: one which serves solely to magnetise the inductors of the other, and a second which produces the alternating current which generates the light. The exciting machine has either a commutator or a collector, which contains as many interruptions as there are coils under induction, and frictional contact-pieces passing successively over each of these divisions, and in intimate contact with them. The smallest imperfection in the working of this essential organ of the machine modifies or destroys the magnetic power of the inductors, and immediately affects the light.

I have sought means for giving to each of these two types of machine the advantages of the other; and I think I have arrived at a satisfactory solution. The problem was a complex one. It was necessary:—1st to arrange so as to have but a single machine to set in motion in lieu of two, and 2nd to get rid of all the drawbacks of the commutator, which is attended with considerable loss both when it produces sparks and when these are avoided. In the latter case it is necessary to short-circuit the current for a certain period at the moment of the change in the direction of the current, and the loss is equivalent. If, instead of a commutator, we adopt a collector similar to that of the Gramme machine, the loss of useful work, though not so evident, is scarcely less. Four or six of the coils under induction are short-circuited at each revolution; it is a case of the commutator which gives no sparks. These coils produce necessarily an extra current at the moment of the change in the direction of the current. The breadth of the brush and the great number of conducting wires of which it is formed may divide and dissimulate the spark, but none the less it exists. The loss of useful work is therefore very nearly the same in the two cases.

The arrangement I have adopted will, I think, overcome all these drawbacks. There is no necessity to throw the alternating currents into the same direction in order to produce the magnetisation of the inductors. In the case of the magneto-electric machine, let us suppose that each of the permanent magnets which constitute its inductors is provided with two coils A B, C D.



These two coils are independent of each other. If a current enters at A and leaves at B in the first coil, and enters at C and leaves at D in the second, we shall always have at P and P_1 two poles of contrary sign. If the current traverse only the coil A B, without passing through the coil C D, the electro-magnet A B C D will still have its two poles at P and P_1. And the same will be the case if the current should traverse only the coil C D, entering at C and leaving at D, without passing through the turns of wire on the coil A B.

I have at my disposal an alternating current, that is to say one which regularly changes its direction each time that a fresh coil in the ring arrives opposite the pole of one of the inductors. Let us now consider the shaft M N of the machine, which carries, besides the circle of coils under induction, the collectors E E_1, upon which bear the frictional contact-pieces F F_1, from which the current is taken. I have added to the collectors E E_1 two other collectors e e_1. These are divided into as many equal parts as there are coils in the ring; and, since there are sixteen of these, e and e_1 are divided into sixteen equal parts. Eight of these parts

* The writer probably means by this expression the EMF under which the current is produced.—Ed. *E.*

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are sunk so that the circular surface of the collectors *e e* presents successively a raised surface and a depressed surface of equal extent. Each of these divisions of *e* e_1 corresponds to a coil upon the ring. The collectors *e* e_1 are keyed to the shaft M N so that a raised portion of *e* may be exactly opposite a depressed portion of e_1. Conductive contact exists between *e* and E, and between e_1 and E_1.

These details being understood, I attach the extremity A of the coil A B to the contact-piece F, and the end C of the coil C D to the other contact-piece F_1; the two other ends B and D of the coils communicate with the lamp L. Moreover, the end B of the coil A B is connected with the contact-piece *f*, and the end D of the coil C D to the contact-piece f_1.

Let us now examine what will take place during the movement of the ring. Let us suppose the piece *f* to be over one of the depressions on *e*; in this case f_1 will be on one of the raised portions of e_1. The current will traverse the coil A B, pass to the lamp L, and return to the machine without traversing the coil C D, since its terminals are united through the collector E_1 e_1. When *f* passes from a depressed to a raised portion of *e*, f_1 will pass from a raised to a depressed portion of e_1. The direction of the current is now altered, and is opposite to that indicated by the arrows in the cut. The current enters the coil C D at C, and leaves at D, passes to the lamp L, and returns to the machine without traversing A B, since the terminals of this coil are connected through the collector E *e*.

One of the two coils of the electro-magnet is always in action. We work with a one-sided electro-magnet, in which the excited coil is alternately on one or on the other arm of the magnet, according to the direction of the current. We can in this manner obtain, by means of alternating currents, magnets so powerful that one of them in my possession is able to support more than 500 kilograms.

If the coils of the electro-magnet offer much resistance, an extra current spark will appear at the contacts made by *f* and f_1. But this spark does not result in any loss of light. It does not belong to the current which passes by the lamp L, and, were it not for the objection that in course of time it deteriorates the contacts, I should allow it to remain. But, in view to the preservation of the machine, it is best to get rid of it.

We know that, in order to produce a powerful magnetisation, a current of large quantity and weak tension is necessary. Of the sixteen coils which form the ring, I take four, which I connect for quantity, and which furnish the current required for the stout wire composing the coils of my magnets. Here there is no longer any spark at the collector, and the magnetisation is considerable. The small model of my machine, which produces, with its permanent magnets only, and the sixteen coils on the ring, a light equivalent to 170 gas burners, can be worked with its magnets surrounded with the coils, and with only twelve of the coils on the ring—since four of the coils constitute the special magnetising circuit. The light produced is then equivalent to at least double that generated under the former conditions.

I have, therefore, demonstrated in theory and in practice that it is not necessary to send in the same direction the alternating currents in order to work dynamo-electric machines. The consequences of this fact are of the greatest importance. The losses of current necessarily occasioned by commutators, or by collectors sending the currents in the same direction are here absolutely avoided. It is no longer indispensable to have two machines in motion in order to produce the alternating current. The magneto-electric machine can render the same service as the dynamo-electric machine, whilst at the same time preserving its own special advantages. Lastly, the cost price of the generator is reduced. We have, then, an important progress here realised in the generator of the current.

I hope soon to be in a position to indicate another improvement in relation to the lamp, when I have the honour of bringing before the conference this second portion of the application of electricity for the production of light.

PHYSICAL SOCIETY.

April 10.—Professor Fuller in the chair. New members: Mr. W. O. Smith, Professor Judd, F.R.S. A paper on the human eye as an automatic photometer, by Mr. William Ackroyd, F.C.S., was read. It is difficult to get the value of a very intense light in terms of a weak one, because the relative physiological values of the similarly coloured constituents are unknown. The author's experiments were made to show that the eye itself is a fairly good light measurer. When a "spot" or star of light is looked at from a distance, it is seen to emit "rays" or spokes of light at all angles. These are due to the structure of the crystalline lens, and the lachrymal fluid on the surface of the cornea of the eye. The rays are of various lengths, and are shorter in the 1st and 2nd qradrants next the nose, near the blind spots, than on the 3rd and 4th quadrants, a fact probably due to the insensibility of this region. The iris expands and contracts under the stimulus of light independently of the will, and both ires act sympathetically. Now, the iris lies between the seats of irregular refraction, and thus any change in the size of the pupillary aperture will be rendered evident by an alteration in the length of the longer rays of a spot or point of light. On this fact is based the use of the eye as an automatic photometer. The sensitiveness of the iris varies in different persons, the author finds that a spermaceti candle, burning 120 grains per hour, produces a distinct movement of the iris when 14 yards distant. In employing the eye as a photometer the author adopts the principle that if the light from one source A, falling on the eye, is capable of producing movement of the iris at a distance *d*, and the light from a different source B is capable of producing the same movement at the distance *d'*, then the relative intensities can be found in the inverse squares of these distances. To carry this out in practice the observer is in the dark, and an artificial star is placed on a level with the eye at a fixed distance. Below this is placed the light to be tested in the same plane. While gazing steadily at the star the other light is to be eclipsed and revealed, and the observer is to find a position where the revealing of the second light does not influence his iris; no apparent shortening of the rays of the star taking place. He then approaches gradually till a second position is resumed, where the revealing of the second light does produce a movement of the iris. The distance between these two positions *d* is measured. A third light is now put in place of the second, and the same observations repeated, so as to get a second distance *d'*. From these distances the relative intensities are calculated. The author's results agree pretty closely with Rumford's photometer, but he found that for some reason the two first observations have to be discarded as too inaccurate. Owing to the sympathy between the two ires these experiments were binocular. This sympathy may prove convenient in constructing an eye-photometer, since one eye can be turned to the light to be estimated, while the other is looking at the artificial star. This method of photometry would be too delicate for comparing powerful electric lights unless aided by mechanical means.

Professor Ayrton then offered an explanation of the experiment shown by Professor Guthrie at last meeting, to the effect that while flannel rubbed with ebonite was + electrified, and ebonite rubbed with glass was +, flannel rubbed with glass was —. Professor Ayrton accounted for this apparent anomaly on the grounds that one or more of the substances was an electrolyte. Glass, for instance, is an electrolyte, and a battery had been made from it. Experiments made by Professor Perry and himself had shown that in a "pile" made up of divers substances (one or more of which were electrolytes, though the rest were metals), the electromotive force of the pile was equivalent to the algebraical sum of the several "pairs" composing it, but it was not equivalent to the electromotive force of the first and final plates made into a pair. That could not be predicted from the contact electromotive forces of the elementary pairs; when only metals were employed it could, but not in cases where an electrolyte entered. This same result would apply to Professor Guthrie's frictional experiments.

In answer to Professor Guthrie's question whether electrolysis did not come into play in Professor Ayrton's experiments, Professor Ayrton replied that it could not operate to a greater extent than in Professor Guthrie's experiments.

Dr. Stone then described a new tonometer, devised by Professor Rudolf König, which he had recently seen in Paris. It consisted of a clockwork working into a tuning fork, which produced no less than 128 escapes per second. To this clockwork, originally invented by an assistant of M. Breguet, and exhibited at the Paris Exhibition of 1856, Professor König had added a Helmholtz vibration microscope moved by the clock, and the fork whose vibration number is to be measured is placed vertically in the focus of the microscope. The apparatus is very portable, and no loading of the focus is required. Professor Hughes observed that he had patented a vibrating regulator in 1856.

Dr. Guthrie then exhibited an electric machine, formed of a collodion disc rubbed with cat's fur, and giving negative sparks. The collodion, after a suggestion of Captain Abney, was put on by giving a disc a coat of collodion, then a coat of india rubber dissolved in benzol, then a coat of collodion again. Prof. Guthrie also showed that an iron cylinder revolving round its longer axis, and with a current flowing in a wire parallel to it, has power to deflect a magnetic needle.

Professor Ayrton stated that he had found the mere rotation of an iron cylinder produce the deflection in question, and, therefore, thought the current was not required to produce the effect shown.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

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THE PROGRESS OF TESTING.

In our article of last week under this heading we did not pretend to give more than a brief sketch, embracing the most salient historical points relating to testing; but the length of a single article did not permit us to do justice to the question, even in this limited sense. We, therefore, do not hesitate to continue the subject. We followed up principally in our last the testing of submarine cables. We have now something to add on land line testing, as well as some additional points on submarine cable testing. In October, 1852, Sir C. Bright and his brother, E. B. Bright, patented the use of resistance coils, and two similar galvanometers, to find faults in lines, the current from a battery being divided between a circuit formed by one galvanometer and the line, and a circuit formed by the other galvanometer and the resistance coils, and the resistance altered until the deflections of the two galvanometers were equal. The system was neglected, and, as we have before remarked, differential galvanometers came into use about 1858. Mr. C. F. Varley was the first to introduce resistance coils to the Electric Telegraph Company about this time, and his unit of one statute mile of No. 16 copper wire was used in the company for a considerable time, and also in several cable expeditions. In January, 1859, Mr. F. C. Webb localised a fault in the Cagliari and Malta cable, 170 miles from Malta, by means of a differential galvanometer by Brittain, made on Mr. L. Clark's pattern, with resistance coils made by Varley. In 1858, Sir W. Thomson used shunts in his tests of the Atlantic cable, and gave them that name, but did not, we believe, publish any particulars, and in the same year, Mr. W. H. Preece applied a shunt to one coil of a differential galvanometer, and in his paper, read before the Institution of Civil Engineers, "On the Maintenance of Submarine Cables," in 1860, he fully described accurate testing. In 1861, Mr. Varley became engineer to the Electric Telegraph Company, and soon after he introduced the system of testing the lines regularly every morning for resistance of conductor, and for resistance of insulation expressed in units of resistance. Mr. C. F. Varley patented, in 1862, an instrument called the "universal testing apparatus," instructions for using which were issued in 1863, and which was largely used in the Electric Telegraph Company. It was a differential galvanometer with varying shunts to one coil, so as to be able to multiply, and various keys and switches. Mr. Varley also introduced the loop test in 1863.

These daily tests were taken by the differential galvanometer and resistance coils, but when Mr. Culley became engineer in 1866 he introduced the tangent galvanometer to take the morning readings for insulation, but still reducing to units of resistance, tables being used to facilitate the calculation. This saved considerable time, but even this has been found to occupy too much time, and, besides, there are sources of error when the line is long. About a year ago Mr. W. H. Preece, therefore, adopted the measurement of the received current on a tangent galvanometer from a known electromotive force at the distant end. The current being reduced to milli-webers is compared with what should arrive if the insulation were perfect. Monthly tests are still taken of the resistance of conductor and of insulation. The conductivity of the iron wire has for many years also been measured before acceptance from the manufacturer, but from what date we are uncertain. Mr. Schwendler, in the preface to the first volume of his London second edition of "Instruction for Testing Telegraph Lines," seems to write rather as if he was the first person to start accurate testing of lines, and had set the world right on this subject. Thus he says, "During my stay in Europe, I have had many opportunities to watch the working of other telegraph administrations, and have been surprised to find how little progress testing has made. I was always told 'Yes, we should like to introduce a general system of testing; we know its great practical utility, but show us a system to do it, and which will work satisfactorily.'" We do not know to what administration Mr. Schwendler alludes, but Mr. Schwendler went to India with Mr. F. Lambert, of Mr. Clark's office, in about 1867 or 1878, and his first instructions were issued in 1869, or about eight years after regular and systematic testing had been introduced by Mr. C. F. Varley; and certainly all submarine cable administrations had, since 1859, perfect arrangements for testing, and to use Mr. Schwendler's own words, have been able to "*measure*" and "*know*." Indeed, one of Mr. Schwendler's instruments, described in the second volume of his Calcutta second edition, and called the "Calebrated Galvanoscope," is a horizontal galvanometer, the deflections of which are observed with one Daniel element, and different resistances in circuit and tabulated. This is nothing more or less than the system used by Mr. F. C. Webb in the tests of the Hague cables in 1853 to 1857, described in Mr. Webb's paper read before the Institution of Civil Engineers in 1858, and alluded to in our article of last week.

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Reverting now to the system of expressing the insulation in units of resistance, many improvements have been made since Mr. Siemens first introduced the system in 1859. The deflections were at first taken on a sine galvanometer, involving the use of tables of sines. The Thomson reflecting galvanometer did away with this, and gave far more accurate readings. The constant of the instrument was first taken with one element only, without any measurement of the ratio of its electromotive force to that of the whole battery except by taking the number of elements, all of which were assumed of equal electromotive force. This was followed by the measurement of electromotive force of the single cell by the throw of the needle from the discharge of a condenser charged from the cell, and comparing this with the throw from the condenser charged with the whole battery, but with a shunt on the galvanometer. This was due, we believe, to Mr. J. C. Laws, and the first condenser was made by Mr. F. Lambert for Messrs. Bright and Clark in 1863. Afterwards more than one element was used for taking the constant, and Mr. H. Taylor eventually—we forget in what year—constructed a whole megohm of resistance so as to be able to take the constant of the instrument with the power of the whole testing battery. This system is always adopted now. Professor Matthieson, in giving us tables for reducing the resistance of copper to that at any given temperature, has rendered immense service; but we have no means at hand of determining at what date—probably about 1862. Professor Fleeming Jenkin, and the Committee of the British Association did good work in giving us a standard unit of resistance in 1865, and in arranging and deciding on the units of quantity, electromotive force, capacity, and current. The system of testing by Professor Thomson's electrometer is now much used where short lengths of india rubber core have to be tested, as the high resistance of this material (about ten times that of gutta percha) renders the measurement of the insulation of short lengths by galvanometer difficult. In testing on board ship when paying out a cable the Telegraph Construction Company employ, combined with Willoughby Smith's speaking during testing system, an arrangement of the bridge in which a resistance of 10,000 ohms forms one of the four resistances, the cable forming the following one on the same side of galvanometer. The other two consist of an ingenious arrangement of coils and two slides, invented by Mr. Varley, by which the connection from the galvanometer can be rapidly altered from one point in the resistance coils without any plugging and unplugging.

In testing for the distance of a broken cable end the resistance of the end, as we have before remarked, is a variable and unknown quantity. Attention was called to this by Mr. F. C. Webb in his paper before the Institution of Civil Engineers in 1858, and also to attempts to obtain some information as to this resistance by measuring the "return current" or discharge from the near end. Mr. Werner Siemens, in his paper of 1876, read before the Society of Telegraph Engineers, treats this question mathematically, as had also Mr. Kempe in the *Telegraphic Journal*, and Mr. Kempe has since invented a very ingenious method of taking the reading of the discharge which is likely to make the method of more practical use. The resistance of the end is partly due to an insufficient quantity of copper exposed and partly to that surface becoming coated with chloride of copper, and also to its setting up an electromotive force. If the copper exposed is small the fault can be greatly altered in resistance by using positive currents, but if the amount of copper exposed is great, or if the copper touches the iron wires it cannot, and therefore, by experiments on artificial faults, a rough measurement can be obtained of the resistance of the end. This system is mentioned in Mr. F. C. Webb's report to the directors of the Atlantic Telegraph Company on the distance of the fault in the 1858 Atlantic cable, and published in *The Times* in 1859. Mr. Lumsden, the marine superintendent of the Postal Telegraphs, introduced the following method. He first applies a negative current to clean the end, then a positive current is applied for two minutes to coat the end with chloride of copper. The bridge test is then taken with negative current, and as the resistance decreases, the plugs are inserted to keep balance, but at a certain point the needle gives a sudden fling, and the reading is the true resistance. This system is of great value, and was first published in Culley's third edition in 1868, but was invented probably before.

In the recording of tests during manufacture of submarine cables, a book, called the "Section Book," is kept, in which the absolute resistances, reduced for temperature, of each coil of wire, added to the cable, both for copper and insulation resistance, are noted, and the resistances of the whole cable computed from the same, independently of the tests taken daily. This is of use in finding faults. Many refinements in testing have been added by Messrs. Hockin, Taylor, and Laws, and, doubtless, by some others, which are unpublished, and of which we have only imperfect information. The literature of the general subject of testing comprises Culley's well-known work, now in its sixth edition; Mr. H. R. Kempe's excellent book on testing (1876), which richly deserves a second edition; Messrs. Clark and Sabine's tables, and Captain V. Hoskiær's little work on cable testing, in which the working out of some of the daily tests are given, done by logarithms. Lastly, we have Mr. Schwendler's two volume work, which contains a good deal of excellent information, principally referring to land lines and office testing.

TELEGRAPH WORK IN CAPE COLONY.

On the 8th of November, 1875, and the beginning of the summer season in South Africa our party left the frontier town of Colesberg, Cape Colony, to construct a telegraph line from there across the Transvaal, or Orange Free State, to the diamond fields in Griqualand West.

The Government of Cape Colony, mainly inspired by the growing importance of the diamond fields, had taken a fit of enterprise, and resolved to complete and extend its existing system of telegraphic communication. We had been engaged earlier in the year in connecting King William's Town to Queenstown, and Bedford to Graafreinet, and now our mission was to link the isolated Crown colony of Griqualand to its kindred settlements on the coast. For this purpose the Government had entered into an agreement with the Orange Free State to run the line through that territory by way of Phillipolis, Faurismith, and Jacobsdaal, O.F.S., to Kimberley, the chief settlement of the diamond fields, British territory. The route selected was to follow as closely as possible the postal road across the country. The usual preliminary survey with prismatic compass and chain had been made to stake out the line and determine the amount and proper disposition of the material required for its construction. In erecting a land-line it is not always feasible, especially in a new country, to keep to a bee-line, on account of the precipices, gulleys, and hard ground, which may be avoided by making a *detour*. The pioneer or preliminary surveyor traverses the ground, and examining the country with his eye, selects the next stage of the route, and fixes it by a compass bearing. The distance is then chained, and stakes driven in at intervals of about 90 yards, to mark the future site of each telegraph post.

The whole country over which the line had to pass was a treeless waste. There was not a vestige of local timber fit for poles. The moister regions near the coast are more favoured with vegetation; but even there it is of an intractable nature. Only two species of wood are found to answer for building, and

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especially for foundation purposes—the "sneeze-wood" and "iron-wood." Both of these can withstand the ravages of dry rot and the violent extremes of rain and drought that the country sometimes suffers from. The latter grows large, and may be sawn into poles and planks; but the "sneeze-wood" is as refractory and self-willed as the sensation from which it takes its name. Despite its faults of stubbornness, however, its good qualities are admirable. It is the most durable and strong of all the timber in the colony, and of great service in building. It is very close-grained and heavy, and so very hard that a gimlet pierces it with difficulty. But its crowning peculiarity is its crookedness. Telegraph posts and other beams made out of the trunks present a most unsightly appearance, zig-zagging and bending over in all directions. So tortuous is its growth that it is never dressed by tools further than being peeled. Considering the high prices of transport and the greater handiness of iron poles, it was judged best to adopt a light description of wrought-iron pole, with cast-iron base, in preference to the wooden poles to be had. A pole of sneeze-wood, 18 to 20 feet high, weighed about 250 pounds, whereas an iron pole of the same height weighed only about 120 pounds.

The materials for the line, poles, wire, insulators, and tools, had been brought from England to East London and Port Elizabeth, the north easterly ports of the colony, and brought to us at Colesberg. As there are no navigable rivers or railways in the country, the only means of transport is the bullock-cart, a heavy tilted waggon drawn by a team of twenty or thirty bullocks two abreast. Such a waggon will carry four tons of freight. In these we stowed our iron poles, insulators, and line wire of galvanised iron coiled on drums. Two light camp waggons carried our tents, tools, and stores. Our party consisted in all of two English engineers, a Government inspector, and sixty native Caffirs.

The roads in this part of South Africa are mere waggon tracks across the waste, with the stones flung aside out of the way of the bullock's hoofs. When the holes get a little too deep for personal convenience, the traveller just drives a little aside and mends matters in that way. Thenceforth that will be the high road until the ruts are worn too deep again, and some spirited boer has the enterprise to make a fresh departure. From Colesberg to Kimberley is 175 miles by road, or four days' journey by coach. From Colesberg to the Orange River, the boundary between Cape Colony and the Orange Free State, is seventeen miles. This section of the line was excessively difficult to erect, partly owing to the refreshing rawness of our Caffir material, which seemed to be quite overcome by the awful mystery and importance of its unwonted scientific labours, and partly by the difficult nature of the ground. A tract of land, undulating downwards to the river, lay before us, strewn with immense boulders of black ironstone in desolate confusion. Between these jumbled blocks a thin scraping of soil nourished a dreary scrub of cactus, mimosa thorns, and a species of coarse, wiry grass. Over this soul-depressing wilderness, whose silence is unbroken by cry of bird, the merino sheep and bullocks of the stockmen wander and pick up a scanty forage, followed by their Caffir shepherd, like Arab flocks in the stony deserts of Syria. They are let forth in the morning, and driven home to the kraal at night. No fence marks the boundaries of these great stock-farms; only a marked boulder here and there fixes the marches. The sub-soil is a hard, shaly limestone, which had often, in excavating the pits for the bases of the poles, to be blasted rather than dug out.

Each day we were all up and at work by sunrise, about 4 a.m. The camp waggons were despatched forwards to choose a mid-day halting-place for luncheon. A gang of diggers were sent out ahead to dig the pole pits, each man to one of the stakes driven on the preliminary survey, and armed with pick and shovel. If the ground proved too hard for the pick, it was left to the blasting party which followed, armed with hammer and drill. Then came a gang which placed the cast iron bases in the holes, and filled in and rammed the earth again. While this was being done, the porcelain insulator, protected by its iron hood, was being fixed to the top portion of the pole, which was then raised on end, set into its socket in the cast iron base, and cemented there by a molten mess of sulphur and iron filings, poured in hot. The pole was then ready for the wire, which had been previously run off a portable iron drum, and laid alongside on the ground to be examined for flaws or angles. The wire was next raised up to the top of the pole and pulled by vice and key until it was high enough above the ground, then twisted round the lugs of the hooded insulator and there securely bound with finer wire. In this way, pole after pole was erected, and the wire stretched between. From twelve to one all hands "knocked off" work for the principal meal of the day, and the hungry Caffirs rejoiced in boiled mutton and corn meal porridge, washed down with draughts of their beloved coffee. Your Caffir is as fond of coffee as an Arab, and takes it as black and strong. In Cape colony the Caffirs are thought to be of Arab extraction, and like most other particularly heathen members of the human family, have even incurred the distinction of being the lost tribes. However this may be, the word Caffir is certainly Arabic. We found these primitive fellow-labourers of ours to have, as the Yankee humourist would say, "a deal of human nature" about them. When treated justly, and, above all, calmly, they worked well. With a clear and settled agreement beforehand as to his duties and pay, faithfully and honourably adhered to by the white man, the Caffir fulfilled his part of the bargain ungrudgingly. But let the whiteman lose his temper, they lose respect for him. Passionate themselves, they admire serenity in him.

Dinner over, the work was resumed till sundown, about seven p.m., and after the long day's toil in the burning sun we were all glad to reach the night camp, which had been pitched somewhere near. The waggons had been "coralled" round the bullocks, the tents pitched, and fires of *bois de vache*, or dried cowdung, gathered on the road or in the "veldt," were glowing cheerfully. The Caffirs soon despatched their corn-meal porridge and coffee, and just as soon turned in to sleep—ten to each bell-tent. As for us, we enjoyed a more luxurious supper of tinned meats, biscuits, and coffee, with an occasional treat in the way of a Cape cabbage, which had cost us half-a-crown, and butter at seven shillings a pound.

Between the high banks on either side of the Orange River, we swung the wire right across from pole to pole at one single span of 400 yards, first floating it over on a raft. From the river to Phillipolis the character of the country changed. It was entirely free from the boulders and cactus we had just come through. This cactus proved troublesome to us in a way not anticipated. Sometimes we had to hew our path with hatchets, through thickets of prickly pear fifteen feet high, and perfectly impenetrable. At every blow of the axe the fine pollen of the large yellow flowers filled the air and got into our eyes, causing great irritation, followed by inflammation and temporary blindness. But now we had entered a flat, treeless plain, covered only with a short, coarse herbage, cropped by large herds of springbok.

Although it was now the height of summer, and we expected severe drought, we were agreeably surprised to welcome a rainfall every afternoon, as regular as the clock. Up till about 3 p.m. we had a perfectly clear day. At 3 a little black cloud made its appearance on the northern horizon, and gradually grew nearer and nearer, till down came the heavy tropic shower accompanied by thunder and lightning. In half an hour it was all over again, and the sky as bright as before. It is a mystery to us where the rain came from out of the north, unless it might be from the great lakes in the interior.

Before the rain came on, and heralding the approach of the cloud, but often before it appeared, we found the wire powerfully charged with electricity. We were going north, and the wire lay in part along the earth. By grasping it in the hand, we received a shock like that from a strong battery. One man in fastening the wire to the insulator on a pole, got so violent a shock that it upset him on the ladder, and brought him to the ground. Some days the atmospheric electricity was much more violent than usual. The day before Christmas, just after the completion of the line to Faurismiss, Mr. Thornton, one of the engineers, had occasion to go a little way along the line to examine a fallen pole which had been accidently knocked down. There was a heavy thunderclap before he set out, and a few drops of rain began to fall. He had thrown his macintosh over his head and shoulders to keep off the shower. There were some large ironstone boulders in this neighbourhood, and the line passed amongst them. The fallen pole lay across one of these boulders. He stood upon it, and as he was in the act of stooping to pick up the wire, suddenly a bluish glare blazed all around, and for a moment dazed him. When he recovered his senses, he found the stone on which he was standing split in two between his feet, and the air smelling strongly of sulphur, or, perhaps, ozone. The block of stone was about six feet thick. Beneath it was a water channel, towards which the discharge was probably directed.

Once across the Mudder River, we were again on British territory. From thence to Kimberley stretches another bare plateau, such as we had already crossed. On the outskirts of Kimberley we were stopped by the great mounds of refuse dug out of the "Kopje," or diamond mines, and thrown aside after the washing. The houses of Kimberley were too tall for the wire to overtop them, and the streets too crooked to carry the line along them. The wash-heaps also were too high, and we were not permitted to plant poles on them, because, after the yield of the mines themselves began to fail, some smart digger found it profitable to wash the refuse over again. We were obliged, therefore, to take the line in and out amongst the heaps.

Close to the Kopje stands one of the funniest towns the world

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ever saw, namely, New Rush or Kimberley. It is simply a collection of canvas tents and sheds of galvanised iron, the larger being used for stores and drinking saloons, courthouse, banks, and churches of various denominations. Here dwell the diggers, men of every nation under the sun, except Chinese, attracted together by the glitter of the diamond. The Celestial has not, strange to say, put his foot in there yet to receive his kicks and halfpence smilingly; but one may see any day on the streets or at the bars a Lascar chatting with a Frenchman, a Yankee with a New Zealander, an Irish patriot taking drinks with a Japanese, and even a Russian on friendly terms with a Turk. When all sorts of men meet like this for a common object far from home and old prejudices, they rely only on their common humanity and forget differences of race and creed. A friendly goodwill makes the heterogeneous elements work together amicably. We found the diggers both hospitable and kind, although, perhaps, rather addicted to taking and giving drinks. We were heartily welcomed by them all; for, rough adventurers as they were, they had the feeling that we had somehow brought them nearer by six days to their old homes.

ELECTRIC LIGHTING IN AMERICA.

[The following letter deserves careful reading. It is not often that we can commend the scientific enterprise of newspaper correspondents, but this communication to the *Standard* of the 13th inst. is worthy of reproduction, and we can only hope that the writer may continue to send as good material in the future.—ED. *E.*].

NEW YORK, APRIL 2.

The value of the small incandescent light invented by Mr. Edison last December now begins to be understood. This lamp was a carbonised filament of Bristol board, bent in the form of a horse-shoe, enclosed in a hermetically sealed glass bulb, three inches in diameter, and heated by a current of electricity. The resistance of the filament was claimed to be 100 Ohms. When the public exhibition was given on New Year's-eve there were forty-five of these lamps in use in the buildings and streets of Menlo Park, the light being sustained by three dynamo-electric machines.

I visited the shops a few days ago, and had a long conversation with Mr. Edison. While still confident that his lamp is to be ultimately an unqualified success, Mr. Edison surprised me by saying that only two of his paper carbon lamps were then in existence. The rest, nearly 200 in number, had been destroyed by the action of the electric current, one after the other. From some cause, which no one understood at first, the platinum conducting wires would, after a short period of satisfactory service, suddenly grow hot in some lamp. The glass around the wires would crack, and the pressure of the air outside would burst in the glass at that point, and the carbon would then consume almost instantly. This accident occurred to one of the lamps, finally, while Mr. Edison had it under close inspection. He discovered that the contact between the ends of the paper carbon and the conducting wires was not perfect. A voltaic arc formed there, the wires grew hot, and the lamp was destroyed before his eyes. He sought then to remedy the trouble by copper-plating the ends of the carbon, in order to make a more perfect contact with the conducting wires. This expedient was not successful, and the paper carbons kept going out. Sometimes they would burn out within the lamps without any rupture of the glass bulb. A record having been kept of each lamp, it was found that the average duration of each of them was seven hundred hours.

Two of these inventions are still in use, and are lighted every night. One is in the street, the other is in a house whither the men of the shops resort for their meals. The latter has now endured for one thousand seven hundred hours. It is this circumstance which leads Mr. Edison to believe that the defects of the light can be cured, and that he will yet solve this long-agitated problem of electric illumination of small buildings. This lamp which holds out so well is now being made the subject of special study, and I regret to say that no one who looks at it shares Mr. Edison's opinion. Within the glass bulb of this lamp there is now a deposit of fine black powder, which is thickest in the lower part of the bulb, and which reminds one of the accumulation of dust in the unwashed globe of a gaslight. This phenomenon indicates the early destruction of the lamp. It reveals the fatal and incurable defect of carbon as a material for a small incandescent light. It shows that even in the remarkable vacuum produced by the mercurial air pump carbon will volatilise. This has been the trouble invariably with all this class of inventions in America so far. No carbon vacuum lamp has been produced here the interior of which would not be covered with a deposit of volatilised matter after being in use for a few hundred hours. Rupture of the burner has invariably followed the appearrnce of the deposit in due course of time. Mr. Sawyer, the rival of Edison, has come definitely to the conclusion that this sort of thing cannot be prevented, and he has abandoned all hope of perfecting a permanently durable lamp of this class.

Edison has now been brought face to face with the true character of the problem before him. Nature has supplied only two materials for an incandescent light. He has tried them both, and finds both defective. Platinum melts, and carbon volatilises. The only question seems to be, how long can carbon be made to last? With a view to ascertaining the truth he has begun a new series of experiments. A Professor at Harvard University has sent to him fifty different varieties of fibres of grasses and woods, obtained from all parts of the world, some of them having been obtained for the University during the explorations of Agassiz in South America. He is trying the value of these for carbons. The object is to obtain a filament more tenacious naturally than paper, and one which shall be faultless throughout its whole length. It is fatal to durability to have the filament of unequal size. If at any point in the length of the carbon the diameter is smaller than elsewhere the force of the electric current concentrates there and causes a rupture. Mr. Edison finds that manila fibre is the best of the fifty submitted to him. It is remarkably strong, even, and elastic when carbonised, and gives as good a light as paper. Its resistance is higher than that of paper. About twenty lamps with this material for the burners have now been made. I saw about a dozen of them lighted at Mr. Edison's shops a day or two ago. There is nothing noteworthy about them, except that it takes more power to make them give a sixteen-candle light than it did the paper carbon lamps. When fully incandescent they had the same beauty and brilliance of this class of lights in general. How many can be maintained per horse-power is not known. They would be beautiful lights to introduce into dwellings, and could they be depended upon they would make a great sensation. But I now begin to believe that neither they nor any other small incandescent carbon lamp will ever be introduced to dwellings to any very great extent, unless people decide that they are willing to submit to some inconvenience for the sake of obtaining a light which will not contaminate the air. There is no reason to believe that the manila carbons will last any longer than the paper carbons. The probability is that they will not. People who use the Edison lamps, therefore, must expect breakages, sudden extinction of lights, and other annoyances of a similar character, a fair proportion of which will occur on occasions when they will be exceedingly embarrassing. It is doubtful if any one would wish to purchase additional purity of air in houses at such a cost. I am certain that no one in New York does, nor will any one here give any encouragement to household illumination with these lamps until they are proved to be proof against accident.

Mr. Edison is greatly vexed at the growing popular incredulity in regard to his reiterated assertion that a satisfactory system of illumination has been perfected. He recently asked Professor George F. Barker, of the University of Pennsylvania at Philadelphia; Professor Rowland, of the John Hopkins University at Baltimore; and Professors Brackett and Young, to investigate the subject and announce the result of their inquiries to the public. This committee of scientific gentlemen spent a few days at Menlo Park the early part of the present month, and, the night before last, Professor Barker made a report in the form of a lecture at Philadelphia. He had a number of the carbon lamps in the hall, and used an Otto silent gas engine, consuming twenty-one cubic feet of gas per hour per horse-power, to generate the current. The lecture was an interesting exposition of the qualities and modes of generating the electric light, but contained no new and important imformation. It was, in fact, a disappointment to all who were hoping for a close criticism of the value of Mr. Edison's achievements. Of the durability of the lamps at Menlo Park nothing was reported except that one of them had lasted for more than six hundred hours. The fact that disaster had overtaken them all except two was not referred to. Of the economy of the light it was admitted that, so long as gas can be made for sixty cents. per thousand cubic feet, the electric light can be produced no cheaper. Professor Barker repeated the claim which has been made at Menlo Park, that ten sixteen-candle lights can be produced per horse-power, but no demonstration of this was made. This is a vital point. Mr. Edison hopes to obtain ten good lights per horse-power, but he does not do it yet. It is upon his ability to do that that the whole claim of superior economy of the incandescent light is based, and why this unsupported assertion should continually be made by himself and his friends surpasses all comprehension. It is doing him great injury in the estimation of all practical men. It is his well-known failure to maintain more than

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four lights per horse-power which, combined with the breaking of his lamps, has put an end to the speculation in the shares of his company, and made buyers unwilling to take them at any price. Proof that ten lights per horse-power can be maintained would revive that speculation, but Professor Barker presented none, and his assertion on this point is received here by nearly everybody with a look of wonder and a suggestive silence. Mr. W. E. Sawyer is the only person who has taken any notice of the matter. He lately challenged Professor Barker, in a letter printed in the *Tribune*, on this point. He denies that Edison can obtain more than two sixteen-candle lights per horse-power. A controversy between the two inventors would possibly lead to a disclosure of the exact truth of the matter. Meanwhile, it must be said that Professor Barker's Report has not dispelled the popular incredulity about Edison's light, and has made no sensation whatever. In fact, the lecture having failed to make out a case for Edison, the old saying is again heard that Edison may yet die a disappointed man.

Since writing the above I have received from Professor Barker a private letter giving the data obtained by him and Professor Rowland, in regard to the efficiency of Edison's machines, and the number of lights obtained per horse-power. These data are interesting, although unsatisfactory. The point to be ascertained was the number of sixteen candle-lights which could be maintained in a long circuit per horse-power of energy expended. Menlo Park is the only place in America where a practical test of this sort can be made. There are scattered throughout the streets and buildings of that village as many as fifty carbon lamps, the number of which could easily be doubled in a day's time. The conducting wires are all strung, and everything is at command for an experiment. It is surprising to learn that the plan of measuring the power developed by the engine, and of counting the number of lamps in circuit giving out a sixteen-candle light, was not resorted to. Nor was the plan of measuring the resistance and amount of current passing through a single lamp made use of. Instead of that a laboratory experiment was tried. A hollow vessel of very thin copper, called a calorimeter, was made, holding about 2½lb. of water. The lamps were taken in pairs. One was put into the calorimeter, and the rise of temperature per minute noted. The other was placed in an apparatus for measuring its photometric power. Then the process was reversed. The second lamp was placed in the calorimeter, and the photometric power of the other was measured. The mean of the two results was recorded. It is well known that a rise of temperature of 1 deg. in one minute in a pound of water represents 1-43d of a horse-power of energy expended. The data collected were as follows, the last column being obtained by deducting 30 per cent. for loss of power by friction in the engine and generators and resistance in the conducting wires :—

Registered number of the lamp used.	Photometric power.	Energy expended per minute in foot pounds.	No of 16-candle lights per horse-power.	No. of lights per horse-power, after deducting 30 per cent.
201	13	3486	6·8	4·8
580	10	3540		
580	29	5181	12·8	8·9
201	33½	4898		
850	14	2483	8·3	5·8
809	9	3330		
817	17	2708	13·1	9·2

Increased efficiency with rise of temperature is shown by the table, and Professor Barker says :—"There is no reason, provided the carbons can be made to stand, why the number of candles per horse-power might not be greatly increased, seeing that the amount which can be obtained from the arc is from one thousand to two thousand candles per horse-power." The experiment is not satisfactory as to the number of sixteen-candle lights obtainable per horse-power, however. The estimate of 30 per cent. for loss of power by friction and resistance is theoretical. It is very well known that in the laboratory one horse-power can be generated by the combustion of one-sixth of a pound of coal. But the best compound engines consume at least two pounds of coal per horse-power, ordinary condensing engines five pounds, and the non-condensing anywhere from four to ten. This is widely different from the laboratory result. The latter is purely an ideal effect, never produced in practice. I do not, therefore, regard Professor Barker's conclusion of from four to nine lights per horse-power as scientifically correct, because he does not know the actual loss of energy in distributing a current over a long circuit under practical conditions. The Professor says he is not sure that lamps can be made cheap enough or durable enough, after all; and here again comes to view the fatal defect of the carbon lamp.

Mr. Sawyer has now given up the idea of attempting to perfect an incandescent light pure and simple. He has abandoned all effort in that direction, after two years of constant experiment. His only hope at present is to be able to manufacture a style of lamp suitable for factories. He has modified his recent lamp in such a manner as to make it substantially a Werdermann light, differing therefrom only in the circumstance that the whole apparatus is enclosed in a sealed glass chimney, containing nitrogen gas. He finds that it will burn 500 or 600 hours, and is practical for use in large buildings. A company has been formed to manufacture the invention for this special field of illumination. A public exhibition was given at Mr. Sawyer's shops in this city the early part of the present week.

It is remarkable that the only electric light which has been put to use in the United States so far has never made any public parade, and has never caused any agitation. About two years ago Mr. Brush, of Cleveland, Ohio, perfected a regulator for the voltaic arc, which he exhibited at two or three industrial firms, and which then went at once into practical employment, without attracting especial public attention. There has been no public exhibition of the light for a year or so, except on one occasion last summer, when the ingenious proprietor of a hotel at Niagara Falls conceived the idea of illuminating that cataract at night, and advertised his achievement in nearly every American city, in order to attract visitors to the Falls. In spite of the absence of bulletins, however, the lamp has been the subject of study on the part of the owners of large buildings, and has been adopted extensively in place of other modes of lighting. The voltaic arc has been proved by this invention to be perfectly manageable, and to give an excellent and useful light, and, whilst it is not always very much cheaper than gas, sometimes it is remarkably so, and it is rapidly becoming very popular. Twenty or thirty factories are now employing it in different parts of the country. Several large stores in New York City are lighted by it, and Mr. John Wanamaker, of Philadelphia, the great clothing merchant, has just put it into his warehouse. The Pottstown Iron Company are employing it, so as to run their nail factory all night. They never could get light enough for this purpose in their dingy works until the voltaic arc was utilised. They do not know whether the light is cheaper to them than gas, and they do not care. They know that for the first time they are now able to run all night, and they do not care for the cost. Mr. Wanamaker saves 69 per cent. on the cost of gas and gets more light. In New England, where the cotton mills have an abundance of water power, the companies find that the new light diminishes their gas bills about one-half. One company has purchased five generators, costing 10,000 dols., and 80 double lamps, costing 6,000 dols., investing in wires and all about 17,000 dols., and has been able to dispense with a consumption of 12,750,000 cubic feet of gas a year, saving 71 per cent. on annual cost of illumination. The exact figures are 28,867 dols, previous cost of gas ; 8,260 dols., present cost of electric lighting. But this is an exceptional case, because there is no expense for power. Sometimes the saving is so small as to be of no account; the new light being employed because there is several times as much of it for the money, and because it does not heat and vitiate the air. This style of light has now been employed for about a year, and being no longer a subject of experiment and uncertainty, the newspapers are ceasing to take notice of it. The Brush concern now has eighteen hundred lamps in use, and has sold three hundred and fifty thousand dollars worth of machinery and apparatus. These figures may possibly be interesting to English makers of electric lights, as showing what can be accomplished with a good light.

NOTES ON SOME EXPERIMENTS WITH THE TELEPHONE.

BY JAMES BLYTH, M.A.

While experimenting with an ordinary Bell telephone, of small resistance, I found that it was able to reveal the existence of electric currents produced by the mere friction between conducting substances. This was shown in the following way. Two files had wires firmly connected to them, and were thereby attached to the terminals of a telephone circuit in a distant room. When these files were rubbed against each other, a most distinct grating noise was heard in the receiving telephone. In order to find if this sound varied, when different substances were rubbed together, the following plan was adopted. A wire was firmly attached to a small table-vice, and led to one of the terminals of the telephone circuit, while the wire from the other terminal was attached to a clamp into which any substance, which it was desired to test, could be screwed. Different substances were then screwed into the vice and clamp, and rubbed against each other by an assistant, in each case, as far as pos-

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sible, with the same pressure. By listening attentively in the receiving telephone, I endeavoured to detect any variation in the sound as the assistant passed from one substance to another. As far as I could judge, little or no variation was produced when the following substances were rubbed on themselves and on each other, viz., steel, brass, iron, zinc, lead, gas carbon, copper, with possibly the exception of copper on iron, which, I thought, gave the sound a little louder.

It was different, however, when two pieces of antimony and bismuth were rubbed together. In this case the sound was decidedly louder. I tried also, with a very distinct effect, antimony rubbing on gold, and antimony on silver.

In order to augment the currents, and consequently the sounds produced in this way, I took a large iron fly-wheel mounted on an axis which ran in centres. By a wire attached to one of the centres this wheel was connected to one of the terminals of the circuit, while a file was connected to the other terminal. The wheel was then driven rapidly round, and the file held hard on to its rim,—so hard that sparks of fire were produced by the friction. In this way a very distinct noise was heard in the receiving telephone. I have also made a variety of the above experiment by mounting a small cylinder of antimony in a turning-lathe, and driving it round against a bar of bismuth. This produces the loudest and most distinct noise of anything which I have yet tried.

These experiments demonstrate, without doubt, the existence of currents produced in conducting substances by friction alone, but it becomes a question whether they are to be regarded as merely thermo-electric, or whether they are not the very currents referred to by Sir William Thomson as the probable cause of friction, and by Professor Tait, in his "Thermo-dynamics," where he says, "it is possible that all friction, not excepting that caused by actual abrasion, is due to the production of electricity."

Instead of rubbing the substances together, I next proceeded to try the effect of knocking the one against the other. For this purpose a small anvil was put into metallic connection with one of the terminals of the circuit, and a hammer similarly connected to the other. Each stroke of the hammer on the anvil was very faintly heard in the distant telephone. As a variety of this experiment I put a small quantity of detonating powder on the anvil, and came down upon it with a blow from the hammer. I thought that it might be possible to hear something of the sharp snap produced by such a blow. The sound, however, heard in the telephone was not appreciably louder than before. Another variety of this experiment was made by driving a wheel, with large teeth, rapidly round in the turning-lathe, and holding against it a strong metal spring. The rapid clicks produced in this way were heard even when the telephone was a short distance from the ear. Here, however, it is plain that we have a mixture of the effects produced by rubbing and knocking.

In my next experiment I took a phonograph, and so arranged it that a telephone circuit was completed through the spring which carries the pricker, the pricker itself, and the cylinder. When the pricker was allowed to press hard into the groove, and the cylinder turned, a faint grating noise was heard in the telephone, unless at those points where there happened to have been regular serrate markings left by the tool in cutting the groove, and then, as the pricker passed over these, a sound more or less resembling a feeble attempt at an articulation was heard. I then put a sheet of tinfoil on the phonograph cylinder, and spoke a sentence loud and distinct into the mouthpiece, and, for the purpose of increasing the sound, as heard in the telephone, I also included two Bunsen cells in the circuit. When the phonograph was now turned, so as to reproduce the sentence, the articulation was heard in the receiving telephone, loud enough certainly, but considerably marred by the mere rasping of the pricker on the natural inequalities of the tinfoil.

It is obvious that, in this experiment, the articulation, such as it is, heard in the telephone must be caused by the variation in the resistance to the current, which arises from the unequal pressure of the pricker upon the tinfoil as it follows its indentations. This has, I think, an important bearing upon the character of all curves got by different processes of enlargement from the tinfoil record. Such curves could only accurately correspond to the movements of the disc which produced the indentations, provided the style attached to the lever, for producing the enlargement, pressed exactly on the tinfoil as the pricker did. Now, seeing that the pricker does not press equally at all times on the tinfoil, it would be very difficult, if not impossible, so to arrange a style and enlarging lever as to press in a manner so exactly similar.

The telephone can be employed to illustrate in a very pleasing way, the incipient stage in the breaking-up of a liquid vein into globules. For this purpose a vein of acidulated water is made part of a telephone circuit, which also includes one or two Bunsen cells. This is easily managed by attaching a metallic can, having a small orifice in its bottom, to one of the terminals of the circuit, and a shallow metallic basin to the other. The first vessel, being now filled with acidulated water, is held over the basin, so that the column of water from the orifice flows into it, and so completes the electric circuit. By gradually raising or lowering the upper vessel, a longer or shorter column of liquid can be made part of the circuit. On listening in the telephone, so long as the liquid vein is short and limpid, no sound whatever is heard. This shows that the electric current has uninterrupted circulation. On gradually lengthening the liquid vein, a point is reached when a rattling noise is heard in the telephone. This arises from the altered resistance caused by the liquid vein beginning to break up into globules. On still further lengthening the vein, a point is very soon reached when all sound in the telephone again ceases. This corresponds to the stage when the liquid vein has actually separated into detached drops, and so broken entirely the electric circuit.—*Proceedings of the Royal Society of Edinburgh.*

NOTE ON SOME EFFECTS PRODUCED BY THE IMMERSION OF STEEL AND IRON WIRES IN ACIDULATED WATER.

BY PROF. D. E. HUGHES.

During a discussion upon a very interesting Paper by our President, "On the Durability of some Iron Wire," I mentioned a fact which I had lately observed, viz., that steel or iron wires immersed for a few minutes in acidulated water, containing $\frac{1}{10}$th sulphuric acid became excessively brittle. Upon repetition of these experiments, I have found that this brittleness is no mere accidental result, due to some flaw in the steel or iron wires, but that the resulting brittleness is invariable in all kinds of steel as well as iron. Nor is the effect due to any specific proportions of sulphuric acid to the water: nor, in fact, as we shall see later, to any particular acid. The effects, however, seem confined to steel and iron, as by similar treatment I have as yet obtained no perceptible effect on copper or brass. Mr. W. Chandler Roberts predicted that the effects were probably due to the absorption of hydrogen. I have tested these wires in my induction balance, but can find no change whatever in its magnetic conductivity, if the conditions of the experiments are such as to favour the absorption of hydrogen. Using two steel wires as electrodes in sulphuric acid and water, we find that both wires have become brittle, though in a very different degree, the wire connected with the zinc or negative pole remaining bright, although excessively brittle, whilst the one connected with positive pole is much corroded, and but feebly brittle, with this arrangement. I believe that these effects are due to the absorption of hydrogen when the hydrogen is in the "nascent" state. Hydrogen seems to permeate through the entire mass, for iron rods $\frac{1}{4}$ inch thick were equally affected, requiring more time, or, in other words, a supply of nascent hydrogen sufficient for the larger mass; and once the wire has become hydrogenised (if we may be allowed the expression), it retains it under all circumstances of time and change of surrounding atmosphere. Heat alone of all the means I have tried has any effect, and if we heat a wire to cherry red in a spirit lamp, we find that it is completely restored to its primitive flexibility in a few seconds. These effects may be obtained over and over again. I have remarked that a wire immersed in sulphuric acid and water of any proportion, say $\frac{1}{16}$th, becomes more electro-negative than at the first instant of plunging. If we take amalgamated zinc as the positive element, and a steel or iron rod or wire for negative, we find that there is such a remarkable similarity of electromotive force between all kinds of steel and iron that we are forced to the conclusion that we are simply testing the electro-negative qualities of hydrogenised iron, the force being with amalgamated zinc ·56. I remarked here a remarkable fact, and which does not agree with the results of many authorities. I found that as soon as the iron rod had absorbed its maximum of hydrogen (a few minutes after being short-circuited) that it became a constant cell, giving but small traces of polarisation then or after being short-circuited for hours at a time. There occurs, however, a slight diminution of electromotive force after a few days' hard work, being then ·52, due to the acidulated water becoming more neutral by the formation of sulphate of zinc and iron. If, however, we wish to restore its full electromotive force, we have only to short-circuit the cell for a few seconds, torrents of hydrogen will be given off, and its electromotive force becomes, on testing of its highest value, ·56. If we short-circuit the hydrogenised iron cell for one minute, and at once test its electromotive force, we shall find at the first instant a certain amount of polarisation, about 10 per cent., but it rapidly recovers, being at its full initial force in ten seconds'

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repose, whilst carbon, platinum, and all other negatives yet tried, did not recover their polarisation in one minute's repose. Comparison was then made with the Smee cell. Practical applications were afterwards discussed, when Prof. Hughes said: In conclusion, I may add that, if hydrogen seems to be an enemy of iron and steel, rendering it brittle, on the other hand it is, perhaps, its best friend in rendering it more negative, and, whilst under its entire influence, completly preserving it from oxidisation or rust.

Mr. C. W. ROBERTS then explained that he had measured the hydrogen occluded in the wire under a vacuum, and found it to be 20 times the volume of the iron wire itself.

Mr. STROH said he had found the brittleness to extend to the centre of the wire; apparently and curiously enough the tensile strength was not affected. Professor Abel, Professor Perry, Professor Adams, and Mr. Alexander Anderson made some remarks on the subject, the latter explaining his theory of the tempering of iron and steel as due to absorbed hydrogen and other gas. Mr. Truenfeldt and Mr. Willoughby Smith pointed out the bearing of the phenomenon on soldering telegraph wire, the latter remarking that it is customary to completely "kill" the sulphuric acid flux in soldering to prevent the free sulphuric acid rendering the wire brittle, and to wash the joint after.

Mr. STROH then read a paper on some experiments showing that adhesion takes place between metal contacts when a current passes. He measured the force due to the current from a single bichromate cell for different metal contacts, and found it to range from 0·15 grammes for copper to 225 grammes for hard steel. He explained the effect as due to fusing the contact points due to heating by the current. We may, perhaps, refer to this paper at greater length in our next issue.

NEW PATENTS, 1880.

1295. ELECTRICAL CONDUCTORS.—(*A communication.*)—*F. M. Allen* (*London*).

1328. TELEGRAPHIC AND TELEPHONIC APPARATUS.—(*A communication.*)—*W. R. Lake* (*London*).

1333. TELEGRAPH WIRES.—*G. F. James* (*Salford*).

1339. ELECTRIC-MOTOR.—(*A communication*).—*J. C. Newburn* (*London*).

1343. ELECTRIC APPARATUS.—*J. L. Pulvermacher* (*London*).

1385. MAGNETO-ELECTRIC MACHINES.—*T. A. Edison, U.S.A.*

1392. DYNAMO-ELECTRIC MACHINES—(*A communication.*)—*W. R. Lake* (*London*).

ABSTRACT OF PATENTS.

3164. DEMAGNETISING IRON SHIPS TO PREVENT DEVIATION OF THE COMPASS, *E. H. Hopkins.—Dated 6th August*, 1879. 6*d*.

This consists in passing one or more straight electro-magnets or powerful permanent magnets, held more or less in the angle of the magnetic dip, over the surface of the deck and immediately over the iron beams from end to end of each beam.

3207. REVERSING ELECTRIC CURRENTS, *W. R. Lake.—Dated 9th August*, 1879.—*(A communication.)* 8*d*.

This relates to a manipulator for submarine telegraphy, provided with or consisting of two keys communicating alternately with one of the discharge terminals and the earth.

3257. SAFES, &c., *F. Wirth.—Dated 13th August*, 1879.—*(A communication.)—(Not proceeded with.)* 2*d*.

A panel in the door of the safe is made movable, so that when pressed inwards an electric circuit is closed and an alarm sounded.

3272. ELECTRIC LIGHTING APPARATUS, *W. R. Lake.—Dated 13th August*, 1879.—*(A communication.)—(Not proceeded with.)* 2*d*.

Two metallic rods are connected with the wires of the circuit, and are placed so that they rise vertically from a socket base, and are parallel to and insulated from each other, their free ends being fork-shaped, with rollers pivoted within the forks. The rollers are of platina, steel, or copper, and a bar of carbon rests upon a portion of the periphery of the two, and descends as it is consumed.

3355. MANUFACTURE OF ELECTRODES FOR THE ELECTRIC LIGHT, *W. Morgan Brown.—Dated 20th August*, 1879.—*(A communication)*. 6*d*.

This consists substantially in an external metallic tube, the combustion of which is slackened by a substance charged within the tube and which is capable of forming with the metal of the tube a combination, which is a bad conductor of electricity and which is constantly reproduced under the influence of the electric current at the same ratio at which it is consumed by that same current.

3368. JOININGS FOR WIRE FENCES, TELEGRAPH WIRES, &c., *T. Young.—Dated 21st August*, 1879.—*(Not proceeded with.)* 2*d*.

This consists in employing a joining or coupling piece or tie of suitable section.

TELEGRAPH SHARE LIST.

COMPANIES.	CLOSING PRICES APRIL 14.		BUSINESS DONE WEEK ENDING APRIL 14. Highest.	Lowest.
Anglo-American Ordinary	59,	⅛	60⅜	59
Do. "B"	88¾,	9¼	89½	88⅛
Do. "A"	33¼,	¾	34¼	32⅛
Brazilian	7¾,	⅞	8	7 13-16
Cuba	9½,	10	9⅞	9¾
Do. Ten per Cent. Pref.	16½,	¾	—	—
Direct Spanish	2,	½	—	—
Do. Ten per Cent. Preference	10½,	11	10⅞	10½
Direct United States	11,	¼	11⅜	11⅛
Eastern	9 1-16,	3-16	9⅜	9 1-16
Do. Six per Cent. Debenture	104,	7	—	—
Do. Five per Cent. do.	101,	3	102	101¾
Do. Six per Cent. Preference	12⅛,	¼	12⅜	12¼
Eastern Extension	8 15-16,	9 1-16	9 1-16	9
Do. Six per Cent. Deb.	105,	8	108	107
German Union	8¾,	9¼	9 3-16	9
Globe Telegraph and Trust	5 11-16,	13-16	5⅝	5½
Do. Six per Cent. Preference	11½,	⅝	11⅝	11½
Great Northern	9⅝,	⅞	9 15-16	9 13-16
Indo-European	24,	5	—	—
Mediterranean Extension	3,	½	3¼	3¼
Do. Eight per Cent. Preference	10½,	11½	—	—
Reuter's	10,	11	—	—
Submarine	235,	40	—	—
West India and Panama	1¾,	⅞	1⅞	1¾
Do. Six per Cent. Preference	7¾,	8	7⅞	7½
Western and Brazilian	7⅛,	¼	7½	7⅛
West. Union Seven per Ct. 1st Mt.	120,	5	—	—
Do. Six per Ct. Sterg.	102,	4	—	—

TRAFFIC RECEIPTS FOR MARCH, 1880.

COMPANIES.	March 1880.	March 1879.	Increse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	3,500 estd.	3,256	244	—
Direct Spanish Telegraph Company	—	—	—	—
Direct United States Telegraph Company	—	—	—	—
Eastern Telegraph Company	43,374	41,225	2,149	—
Eastern Extension Telegraph Company	26,425	26,185	240	—
Great Northern Telegraph Company	16,440	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—

ADDRESSES.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

PETER BROTHERHOOD, Engineer, 56 and 53, COMPTON-STREET, GOSWELL-ROAD, E.C.
Specialities—Patent 3-Cylinder Engines (Silver Medal, Paris), as used by Siemens, Gramme, and Wilde for driving Electric Machines.

RANSOMES, SIMS, and HEAD, Orwell Works, IPSWICH.
Specialities—Portable and Stationary Engines, fitted with patent governors, as tried in the electric lighting experiments on the Thames Embankment.

ABBOTT and Co., NEWARK-ON-TRENT.
Specialities—The "Standard Size" Vertical Cross Tube Boilers. Illustrated catalogue, giving every detail of a variety of Boilers 2s. 6d., post free.

CARBON ELECTRODES COMPANY. Works: 39, COMMERCIAL-ROAD, EAST.
Specialities—Carbon Rods of all sizes for Electric Lighting. Also, Plates and all other Moulded Carbon Goods. List of prices on application.

M. THEILER & SONS, Telegraph Instrument Manufacturers, 86, CANONBURY-ROAD, N. Works: ALWYNE-LANE, N.
Specialities—Morses, Polarised Relays, Saunders' Curb Keys, Type Printers, Recording Sounders, Duplex Apparatus (Theiler's Patent).

HOOPER'S TELEGRAPH and INDIA RUBBER WORKS, MITCHAM and MILLWALL DOCKS.
Contractors for the Manufacture and Laying of Submarine Telegraph and Torpedo Cables. Manufacturers of Hooper's celebrated Insulated Core. Printed reports on application. Offices: 31, LOMBARD STREET, LONDON, E.C.

THE BRITISH ELECTRIC LIGHT COMPANY (Limited), 41, PARLIAMENT-STREET, WESTMINSTER, and 17, WATER-STREET, LIVERPOOL.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

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SLIP

PITTSBURGH.—The Standard Nut Works, of Pittsburgh, Pa., has adopted the Brush electric light.

BOSTON AGAIN.—Some enthusiast now proposes to erect in Boston a series of towers, to place on the summit of each powerful electric lights, and by means of reflectors to light the city.

ANOTHER CABLE.—An organisation to be known as the New York Land and Ocean Telegraph Company has been started for the purpose of laying another cable across the Atlantic.

BOSTON.—The Common Council of Boston will probably pass an ordinance regulating the erection of telephone and telegraph wire to prevent interference with the Fire Alarm Telegraph.

A MEXICAN GULF CABLE.—It is stated that the Gulf Submarine Cable Company will commence laying the cable during the latter part of this month, starting at Brazos Santiago, thence to Vera Cruz *viâ* Tampico.

ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED).—REPAIR OF 1873 CABLE.—This cable, broken off the coast of Ireland on the 2nd inst., was repaired on April 15, and is now in perfect working order and condition.

WABASH.—A short preliminary test of the electric light has just been made at Wabash, Ind., with every indication of success. Should the light prove acceptable, this city will be the only one in the world lighted exclusively by electricity.

MAGNETIC ATTRACTION FOR ELDER PITH.—M. Ader finds that elder pith is, of all other so-called non-magnetic bodies which he has tried, the most strongly attracted. The effect is much more strong when the two poles of the magnet are brought very close together.

NEW ELECTRIC INSTRUMENTS.—Recent numbers of the *Comptes Rendus* contain accounts of two new instruments devised by M. Deprez. One is a galvanometer for measuring strong currents of electricity, and one for continuously registering the total energy of a current.

THE CAVENDISH LABORATORY.—Lord Rayleigh's lectures on Elementary Electricity and Magnetism (experimental) will be delivered in the Cavendish Laboratory thrice a week this term. A fee of two guineas per term is now payable for the use of the laboratory, with instruction.

GLOBE TELEGRAPH.—Interim dividends for the quarter ending the 18th April, 1880, are to be paid of 3s. per share on the preference shares, being at the rate of 6 per cent. per annum, and 2s. per share on the ordinary shares, being at the rate of 4 per cent. per annum, both free of income tax.

WEST INDIA AND PANAMA TELEGRAPH.—The directors, after deciding to place £2,000 to reserve, have resolved to recommend a dividend at the rate of 6 per cent. on the first and second preference shares for the half year ending the 31st of December last, carrying £1,017 to the current year.

THE SOCIETY OF TELEGRAPH ENGINEERS.—On Wednesday April 28th, the following papers will be read:—"On the Resistance of Galvanometers," by Oliver Heaviside, associate; "On the Determination of the Position of Faults in a Cable when two exist at the same time," by Charles Hockin, M.A., member; "On Testing by Received Currents," by H. R. Kempe, member.

A NEW ELECTRIC MARVEL.—*Nature* hears that Professor Graham Bell has deposited in the Smithsonian Institute a sealed packet containing the first results obtained by a new and remarkable instrument conceived by him while in England in 1878. It has to do with the transmission of light by means of electricity, we believe.

STRUCK BY LIGHTNING.—During a thunderstorm which passed over Chertsey and other districts last week, a barn on a farm of the Rev. L. Bennett, at Thorpe, in the occupation of Mr. Bance, was set on fire by the lightning and completely destroyed. In the barn was some valuable machinery, which was also destroyed, as well as a rick of oats. Three men were in the barn at the time, and very narrowly escaped with their lives.

THE CANDAHAR RAILWAY AND TELEGRAPH.—In a minute written by Sir R. Temple just before leaving Bombay for England, the following paragraph occurs:—"I would further mention, for the kind consideration of the Government of India, the name of Mr. Maclean, of the Government Telegraph Department, whose exertions in keeping the telegraph line well up with the advancing railway are well worthy of consideration."

CLERK MAXWELL.—The memorial to the late Professor Maxwell is to take the form of a bust and a collected edition of his scientific papers. The Pitt Press have offered to publish a quarto edition of these in two volumes, and to supply 150 copies at prime cost for presentation to learned societies. The cost of these projects will be £700, but it is hoped to raise £900 in order to furnish an oil portrait by an approved artist. Messrs. Mortlock, of Cambridge, will receive subscriptions.

SOUTH KENSINGTON MUSEUM.—The electric light has been introduced into the South Kensington Museum, and the results are very satisfactory. The experiment has been tried in the hall now best known as that containing the new fresco by Sir Frederick Leighton, P.R.A. There are eight lamps, three suspended on each side and two in the central line, so that the light is equally diffused. It is expected the lamps will be used on Saturdays, Mondays, and Tuesdays till 10 p.m.—*Times*.

NOTICE.—Notice has been received at the Hydrographic Office from the Chinese Government that two telegraph cables have been laid down at Taku at the entrance to the Peitto river. The first of these cables connects the upper corner of Taku south fort with the lower corner of the north fort; the other connecting the China Merchants Steam Navigation Company's landing pier with the north bank of the river. Vessels are cautioned not to anchor near the cables, the locality of which will be indicated by beacons.

THE WEST INDIES.—Complaints have been made that the Spanish colony of Porto Rico, one of the largest islands on the line of telegraphic communication, contributes nothing towards the subsidy paid to the West Indian Telegraph Company, and it is suggested that, until a contribution be paid, the island should be omitted from the list of stations, as it is not absolutely required for a landing-place for the cable. Its Government also insists on the key to every private code of telegrams being lodged with the island authorities before a message under the code can be sent.

FONVIELLE'S MAGNETIC GYROSCOPE.—M. Fonvielle and M. Lontin have recently brought before the Paris Academy of Sciences and the Royal Society of London an interesting apparatus intended to give a rotation to stars and discs of

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soft iron. The apparatus consists of a galvanoscope coil with soft iron stars or discs in place of the usual needle. Over the coil is supported a horse-shoe magnet to adjust the needle-disc, and induce magnetism in it. When the current from an induction coil is sent through the galvanoscope the disc is set into rapid rotation, which can be reversed at will. The experiment is exceedingly interesting, but we believe that it is not new. If we mistake not, Sir Charles Wheatstone applied the same phenomenon to the regulation of an electric clock, at least ten years ago. Perhaps Mr. Sabine can give us fuller information on the point?

The Coming Struggle.—Signs are not wanting that the new French Cable Company is pushing forward its preparations for competing for messages between England and America with the Anglo-American. Already it is in operation as between France and America, its charge being actually 3s. per word, arrangements having been made to reduce to 2½f., or 2s. per word, about the end of this month. The Anglo-American Company, true to its expressed intention of fighting the new competitor, charges 6d. per word as between the Continent and America; and so soon as the new cable is established here, it will go to 6d. per word (and not as one paper has it, 6d. per 100 words) between England and America. The Anglo-American Company will soon have four cables in operation, against the one cable of its rival, and although the competitive rate of 6d. per word will assuredly bring it an enormous increase of messages, it will undoubtedly be in a position to conduct the increased business without delay.

Rain at Will.—General Ruggles, an American, has invented an ingenious notion for producing rainfall at pleasure, and, of course, has patented it. The plan consists in sending up a captive balloon into the air, supporting a platform which bears a supply of explosives, which are fired by means of an electric fuse when the balloon has reached a proper altitude. This is merely a practical application of the well-known fact that artillery practice or the cannonading in battles sometimes breaks the clouds and causes rain. It will probably only answer when the sky is cloudy, for we doubt very much if the explosions will be able to make clouds form in a clear sky. Even if it "squeezes" the clouds already in the sky, it will be serviceable, however, provided it does so effectively, otherwise the play will not be worth the candle. In any case, however, it is interesting to see how electricity is thus employed to produce artificial thunder and rain, a function which is performed in nature by the lightning flash.

Electro-Horticulture.—The following letter appeared in the *Scotsman* of the 18th April:—Sir: The article in to-day's *Scotsman* on Dr. C. W. Siemens' recent experiments in the above connection, reminds me of a question put, and an assertion made, by a certain royal preacher about 2,800 years ago, to wit—"Is there anything whereof it may be said, 'See, this is new?' it hath been already of old time, which was before us;" for I find in the *Border Almanac* for 1873 the following quotation, headed "A Lost Art," from the *British* (Kelso) *Chronicle* of January 12, 1787:—"Last Christmas Day, and frequently since, there was presented at table in Nenthorn House, Kelso, a large asparagus, pease, kidney beans, and cauliflower, equally as good as in summer, all produced without the help of a hothouse, flue, or anything of the like nature. The gardener there lately produced a grown salad from the seed, in a close room, in the space of twenty-two minutes and a half, before a numerous company, by the power of electricity."—I am, &c.—Hugh Cameron.

An Electric Alarm for Level Crossings.—Those crossings where the roadway and railway cross each other at the ground level are usually attended by a watchman, who observes the signal of the coming train, and, closing the gates, prevents vehicles from passing. Accidents, however, have happened from this plan, owing to negligence on the part of the watchman, or failure of the signals to be observed by him. MM. Leblanc and Loiseau, two French engineers, have therefore devised an apparatus for effecting this purpose automatically. It consists of a key placed beside one rail of the line at a distance of a kilometre or two from the crossing, and a signal-box mounted on a post beside the crossing. These two parts are connected electrically through the rail and earth. When a train passes the key the first wheel presses in a lever and completes a battery circuit, which causes a loud bell to ring in the signal box, and also displays a notice "*Defense de passer*" (no thoroughfare) on the front of the latter by drawing back a blind shutter. This notice is in black letters on a white glass ground, which by night can be illuminated by means of a candle or lamp. The bell continues to ring and the notice to show until the train has passed the crossing, when it actuates in a similar way a second lever key, which breaks the circuit and allows the apparatus to return to its original state of rest.

Notes from America.—We have to thank our friends on the other side of the Atlantic for the clippings, notes, and articles so frequently sent to us. It is only by such aid that we can hope to notice the progress going on in the States, and we trust that others who read these lines will, whenever they have an opportunity, send us clippings or notes of an interesting nature. We have been favoured with an article from the *Chicago Tribune*, and have to note that this article is almost worded sentence for sentence as was the article from the *Standard* reprinted in our last issue. Is the New York correspondent of the *Chicago Tribune* and the London *Standard* one and the same person, or has the *Standard* correspondent plagiarised? If we can read between the lines, the original was the production of a well-known and deservedly-popular American electrician. The gentleman who writes to us says: "I enclose you a slip from the *Chicago Tribune*, which contains a truthful and accurate statement of the present condition of Edison's and other electric light systems in this country, and is the only one that I have seen published thus far; I advise you to give it your readers." In another column we give an article on Edison's light, which appeared in the *American Journal of Science*, which a gentleman who should know all about the light has kindly forwarded. At the same time we insert a letter which appeared in the *New York Evening Post* on April 2.

Submarine Cables Trust.—Notice is given that the coupons which became due on 15th inst. will, under authority of the Court of Chancery, be paid by Messrs. Glyn, Mills, and Co., of 67, Lombard-street, E.C., between the hours of 10 a.m. and 2 p.m. Coupons must be left with the bankers three clear days before calling for payment. It will be in the recollection of the certificate holders who attended the last annual meeting that a resolution was passed authorising the formation of a limited liability company to take over the property of the trust and carry out its objects. On preparing the Articles of Association of the proposed new company so many legal difficulties presented themselves that, finding these insurmountable, the trustees abandoned the idea, and having been advised that there was a reasonable probability of the decision of the Master of the Rolls being reversed on appeal, they authorised the necessary steps to be taken to this end. The trustees regret that the large

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number of cases on record having a prior right to adjudication in the Court of Appeal will involve considerable delay, but they have directed every effort to be made to expedite the hearing. Until the appeal case has been heard it would be needless to hold the annual meeting, as no business could there be legally transacted. Certificate holders who have not already communicated their names and addresses to the secretary are requested to do so, together with particulars of their holdings.

On the Electromotive Forces which Appear in Free Jets of Water.—According to M. J. Elster, who considers his investigations proved, if an electromotive force is to arise in a free jet of water, it is necessary that the water particles be in contact with a solid body. That the evolution of electricity takes place only where the particles of the liquid undergo friction, so that only a relatively small portion of the water-jet contributes any thing to the development of electricity. That when the velocity of a jet issuing constantly from the same orifice is varied, the electromotive forces are proportional to the *vires vivæ* of the liquid particles—a relation the reason of which is found in the law of the conservation of energy. And, lastly, that the electromotive force is dependent on the nature of the body which is in contact with the liquid. From these results the author draws the following conclusions :—The motion of a fluid does not by itself produce any electromotive force. Consequently the inference deduced by Edlund from his unitary theory of electricity has not been confirmed. Capillary electric currents are conditioned solely by the friction of the particles of the fluid in motior—in nonhumectant fluids by their friction against the particles of the solid wall, in humectant fluids by friction on the particles of a layer of the same fluid condensed upon the surface of the solid body, which behaves towards the less dense layer like a heterogeneous substance. The capillary-electric currents discovered by Quincke are identical with the friction-currents, first observer by Zöllner, which make their appearance in the rubber of an electrical machine.

Six Lecture Experiments.—(1). The conductivity of hydrogen for heat may be shown by rendering incandescent, by a current of suitable strength, a fine platinum wire which joins the upper and out-bent extremities of two stout copper wires fixed parallel and vertically in a cork by means of glass tubes. The glow of the wire disappears on inverting over it a cylinder of hydrogen, while the gas burns at the mouth. (2). By interposing short bars of different metals in the circuit, the difference in their conducting powers will be shown by the more or less lively glow of the platinum wires. (3). A jet of oxygen may be burnt in a two-necked glass balloon containing sulphur, which is vaporised by the heat of a Bunsen. The gas is best kindled by means of a morsel of charcoal fastened to the end of the jet. This is ignited before introducing the jet into the balloon. (4). The indestructibility of matter may be demonstrated by preparing two sealed glass tubes of equal weight, one of them containing oxygen and a little powdered charcoal. The charcoal may be caused to burn away completely by heating it by means of a small flame; on placing the two tubes on a balance it will be seen that there has been no variation in weight. (5). The usual experiments for illustrating the laws of diffusion of gases through porous plates, are apt to convey to the minds of beginners false ideas as to the rate at which one gas propagates itself through another by diffusion alone. That this is extremely slow, owing to the numerous collisions between the molecules, may be proved by suspending a slip of paper, moistened with lead solution from the bottom of a tall inverted cylinder, into which the stopper is inserted. In the hollow of the latter a little hydrogen sulphide solution is placed. Blackening of the lead paper does not occur for ten to fifteen minutes. Chlorine water and potassium iodide paper may also be used. (6). The diffusion of gases through colloid membranes may be demonstrated by fastening a piece of thin india rubber (from a toy balloon) over the mouth of a funnel, which is then placed in an inverted bell jar. The stem of the funnel is connected (best by a side tube), with a U-tube containing a little mercury. If the bell jar be filled with carbonic anhydride, there will be increased tension within the funnel, and, therefore, a rise in the mercury. If one terminal of a voltaic circuit, including an electric bell, be plunged into the mercury, matters may be so arranged that the mercury in rising shall come in contact with the other, a fact announced by the ringing of the bell. The paper is illustrated by diagrams.

The Electric Light for Lighthouses.—The last report of the United States Lighthouse Board contains some useful facts relating to the electric light, and the modes and appliances employed in generating and adapting it for various uses that are of interest. The report in question discusses (1) the modes of producing electric illumination, (2) the instruments for producing electric currents, and (3) the results of measurements of luminous intensity. On the first point the report makes note of three modes of producing electric illumination—*(a)* by the electric arc, *(b)* by incandescent conductors, and *(c)* by incandescent gases. The report notes that the use of the electric arc is attended with several objections—its unsteadiness, and the wearing away and combustion of the carbon poles; and that, while very ingenious regulators to correct these troubles have been devised, they cannot control the minute accidental variations in the structure of the carbons during their consumption. The poles wear away unequally, the arc shifts its position, and the consequence is frequent and great variations in the intensity of the light. Mention is made of variations occurring within a few minutes from 400 to 2,000 candle-power. Nevertheless, asserts the report, "since the great improvements recently made in the homogeneity of the carbon poles, and in the regulating machinery, and since the introduction of reflectors, the electric arc is no longer too unsteady for practical purposes." The production of the electric light from incandescent conductors introduces the grave objections of great wastefulness of energy (and consequent costliness) and the rapid destruction of the conductors by disintegration. A current, for example, that would furnish an electric arc of 1,000 to 2,000 candle-power, would not generate a light of more than 50 to 100, with platinum wires, and the platinum soon becomes brittle, and breaks up. Better results are obtained with carbon rods placed in exhausted glass tubes; but the rods soon vaporise and disintegrate. The report is unfavourable to such lamps, and gives a list of inventions of this class for reference. Among others, the following instructive example of the great loss of energy resulting from a division of the current is given: When concentrated on a single lamp, a given current gave a light of 65 burners; when divided between two lamps, it was reduced to $7\frac{1}{2}$ each; among three, to $1\frac{1}{8}$ burners each; among four, to $\frac{3}{4}$ each; and among five, to $\frac{1}{2}$ each. The report describes and explains the action of 17 magneto-electric machines, and gives the results of a number of comparative tests of the economy and illuminating power of some of the best-known of these machines and lamps, from which it appears that the Brush and Weston machines make the best showing.

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CORRESPONDENCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We hear that a sealed account of an invention for seeing by telegraphy has been deposited by the inventor of the telephone. Whilst we are still quite in ignorance of the nature of this invention, it may be well to intimate that complete means for seeing by telegraphy have been known for some time to scientific men. The following plan has often been discussed by us with our friends, and no doubt has suggested itself to others acquainted with physical discoveries during the last four years. It has not been carried out because of its elaborate nature, and on account of its expensive character, nor should we recommend its being carried out. But if the new American invention to which reference has been made should turn out to be some plan of this kind, then this letter may do good in preventing monopoly in an invention which really ought to belong to men like Willoughby Smith, Sabine, and other physicists, rather than to any particular man who has money and leisure to carry out the idea.

The plan which was suggested to us some three years ago, more immediately by a picture in *Punch*, and governed by Mr. Willoughby Smith's experiments was this:—Our *Transmitter* at A, that is the apparatus for receiving the light impressions and transmitting them electrically, consisted of a large surface made up of very small separate squares of selenium. One end of each piece was connected by an insulated wire with the distant place, and the other end of each piece connected with the ground in accordance with the plan commonly employed with telegraph instruments. The object whose image was to be sent by telegraph was illuminated very strongly, and by means of a lens a very large image thrown on the surface of the above transmitter. Now, it is well known that if each little piece of selenium forms part of a circuit in which there is constant electromotive force, say of a voltaic battery, the current passing through each piece will depend on its illumination. Hence the strength of electric current in each telegraph line would depend on the illumination of its extremity. Our *Receiver*, at the other end, B, was, in our original plan, a collection of magnetic needles, the movements of each of which (as in the ordinary needle telegraph) were controlled by the electric current passing through the particular telegraph wire with which it was in connection. Each magnet by its movement closed or opened an aperture through which light passed to illuminate the back of a sheet of frosted glass. There were, of course, as many of these illuminated squares at B as of selenium squares at A, and it is quite evident that, since the illumination of each square depends on the strength of the current in its circuit, and this current again depends on the illumination of the selenium at the other end of the wire, the image of a distant object might in this way be transmitted as a mosaic by electricity.

A more promising arrangement, suggested by Professor Kerr's experiments, consisted in having each little square at B made of silvered soft iron, and forming the end of the core of a little electro-magnet, round which the current coming from the corresponding selenium square at the other end passed. The surface formed by these squares at B was to be illuminated by a great beam of light polarised by reflection from glass, and received again by an analyser. It is evident that, since the intensity of the analysed light depends on the rotation of the plane of polarisation by each little square of iron, and since this depends on the strength of the current, and that again on the illumination of the selenium, we have another method of receiving at B the illumination of the little squares at A. It is probable that Professor Graham Bell's description may relate to some plan of a much simpler kind than either of ours, but in any case it is well to show that the discovery of the light effect on selenium carries with it the principle of a plan for seeing by electricity.—Yours, &c.,

JOHN PERRY.
W. E. AYRTON.

RESEARCHES ON THE CONDITIONS WHICH INFLUENCE THE FORCE OF ELECTRO-MAGNETS.

BY M. DU MONCEL.

[Abstract of the Author's Paper in *La Lumière Electrique*.]

At various periods since 1857 the author has experimented on the best form to give to electro-magnets and their armatures; such apparatus being of the greatest importance in the applications of electricity. In the present paper, after describing an electro-magnetic balance, in which the attractions are measured against gravity by means of a rocking lever, to one end of which is attached the armature, whilst the other carries a sliding weight and a scale pan, M. du Moncel treats first of

I. THE CONDITIONS OF FORCE IN ELECTRO-MAGNETS WITH REFERENCE TO THE EXTERNAL REACTIONS BY WHICH THEY MAY BE AFFECTED.

Descartes, and several physicists after him, showed that when a mass of iron is applied to one of the poles of a bar magnet the attractive force of the other pole is augmented, and that this augmentation increases as the mass is increased. M. Dub, endeavouring to bring this phenomenon within the known laws relating to electro-magnets, considers that this augmentation of force is due to the increase in the length of the magnet. But according to this authority the augmentation should be as the square roots of the lengths; whilst the experiments of M. du Moncel show that it varies in a much higher ratio, often tripling the original force. They demonstrate also that it is produced with masses of all shapes which do not sensibly increase the length of the bar, and also when the mass is not in immediate contact with the magnetised core. It is further shown that the extension of the magnetic surface has considerable influence upon the phenomenon. From this the author concludes that the observed increase of "energy" depends mainly upon the effects of magnetic condensation developed at the contact between the two pieces; the secondary effect of which is to stimulate the free pole of the magnet, since its polarities are everywhere mutually dependent.

This conclusion is directly demonstrated by successively placing magnetising helices of different lengths, but constructed with a given length of wire, over a soft iron rod of considerable length. It is found that the helix which surrounds the rod throughout its whole length exerts the least attractive force; although the number of turns of wire is in this case the greatest. The helix giving the maximum effect is that which surrounds the rod only over one-third of its length, starting from the active pole. Now, when these helices envelop cores of the same length as themselves, the effect produced is altogether different; the force then augments with the length of the helices, in a certain ratio which is less than that of the lengths, but which in my experiments seemed to give an arithmetical progression, whilst the lengths were in geometrical progression. The ratio of this progression appeared to increase proportionately to the numbers of elements in the battery. These last results are given only as applicable in a particular case. The effects pointed out explain the relatively great power of horse-shoe electro-magnets with only a single coil on one of the branches, as first employed by the author and called by him *electro-aimants boiteux* (one-sided electro-magnets). With a given number of turns of wire, these are nearly as powerful as electro-magnets with two bobbins.

II. CONDITIONS OF FORCE IN ELECTRO-MAGNETS RELATING TO THE FORM AND ARRANGEMENT OF ARMATURES.

The conclusions arrived at may be formulated as follows:—

1. The attractive force of elctro-magnets of any kind is the greater as the surface of the armature which most directly receives the magnetic influence is the more developed, and as the mass of iron exposed to this influence is the more perfectly brought into relation with the magnetic energy of the electro-magnet.

2. It follows from this that the attraction of electro-magnets with two branches is stronger *at a distance* with prismatic armatures having the broader surface in front of the poles of the electro-magnet than with armatures placed edgeways, whilst the contrary is the case when the attraction takes place by contact. In the case of attraction at a distance, the effects produced may be in the ratio of 59 to 92.

3. The electro-magnetic arrangement, in which the armatures move *angularly* in relation to the line uniting the poles of the electro-magnet, that is, when they are pivoted by one extremity which is in proximity to one of the poles of the electro-magnet, is much more advantageous than that in which the armatures move so as to remain parallel to this line. This advantage is specially manifest in the case of the one-sided electro-magnet, in which the force may vary in the ratio of 125 to 64.

4. Prismatic armatures are attracted with greater force as their surface is greater; but the form of these surfaces has immense influence upon this attraction, since it affects considerably the mean distance between all the points under the influence of the electro-magnet. Thus a cylindrical armature having a surface equal to that of an armature of prismatic form is attracted with much less force than the latter; and the ratio of the forces may be 85 to 44.

5. In consequence of a reaction analogous to the foregoing, the *lateral attraction* in electro-magnets of which the cores project somewhat beyond the coils is infinitely* less energetic than the normal attraction, *i.e.*, that which is exerted in the direction of

* This expression is evidently used in a conversational acceptation.—ED. *E.*

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the axes of the cores: the ratio of these forces may be that of the numbers 33 and 18.

6. Armatures constituted by permanent magnets aid the attraction only when they are arranged at a distance so as to preserve whilst moving a direction parallel to the line uniting the poles of the electro-magnet. Under other conditions the contrary is the case, owing to the fact that the magnetic action exerted upon soft iron is much more powerful than that exerted upon steel.

7. The attractive force due to the momentary closing of a circuit is always, for a given distance of the armature, greater than that resulting from the continuous action of the same current (?), when it is sought to overcome it by augmenting the antagonistic force. This fact may be explained by effects of *vis viva*, and by those resulting from the polarisation of the battery. The ratio of the attractive forces in the two cases is as that of the numbers 136 and 95.

8. When the attractive force of an electro-magnet is divided between several armatures the total force is augmented, but the force of each armature becomes weakened, and the more so as the number is greater. It is from an analogous cause that, when the two poles of an electro-magnet are brought too closely together, the attractive force diminishes; the arms acting as armatures relatively to each other.

9. The attractive force of an electro-magnet and armature which have not previously been used is greater, for a given electrical force, than that of the same electro-magnet and armature after they have undergone a strong magnetisation; and, in order to obtain from the same electro-magnet and armature a force about equal to that which they originally exhibited, it is necessary to reverse the direction of the current. Moreover, this high degree of power is obtained only the first time the circuit is completed.

10. The attractive power of electro-magnets at a distance becomes weakened when from any cause the first closing of the circuit does not result in a complete attraction of the armature; the cause of this, as well as of the preceding reaction, is due to the residual magnetism.

11. The repulsive force exerted by electro-magnets upon magnetised armatures is very far from corresponding to the attractive force that can be exerted upon them by reversing the poles of the electro-magnet. This fact, observed by the earliest experimenters on magnetism, and which is discussed at length by Mussembroeck and the Abbé Nollett, is easily accounted for by the effect of the magnet acting inductively to develop in the armature a polarisation the reverse of that which it actually possesses. When attraction takes place it is favoured by the induction; but the contrary is the case when repulsion occurs.

III. Conditions of Force in Electro-Magnets Relative to the Mass of Iron Constituting the Magnetic Core.

The conditions of force in electro-magnets dependent upon their diameter and their degree of magnetic saturation may, under certain circumstances, be in contradiction with each other. For, if force is gained by augmenting the diameter of the magnetic cores, force is lost when, these cores not being saturated, the diameters are too great; the reason of this being that the inert central mass plays the part of a second armature. Now, it has been attempted to obviate this effect by the employment of tubular cores, which at the same time facilitated alternate magnetisation and demagnetisation; but the considerable diminution of attractive force attendant upon this system caused it for a time to be relinquished. The author then took up the investigation of this kind of electro-magnet, and, after numerous experiments, which were recorded in a memoir presented to the *Académie* in 1862, the following conclusions were arrived at:—

1. The greater force of electro-magnets with *solid* cores is not a consequence of their greater metallic mass; but depends mainly upon the disposition of the polar surfaces in relation to the armature.

2. If the polar extremity of a tubular core is provided with a stopper of iron, which may be of very small thickness, the force of the electro-magnet is nearly the same as though the core were solid; but this effect does not take place if the polar surface be augmented by surrounding the extremity of the tube by an iron ring, which proves that it is not so much the augmentation of the polar surface as the mode in which it is disposed that influences the attractive force.

3. If we consider that in the case of the ring the action is that of an armature, and is prejudicial to the external attraction, as when an electro-magnet influences at the same time several armatures, whilst in the case of the iron stopper there is a concentration of the magnetic effects produced by the different portions of the internal tubular surface, it is easy to understand why, by the magnetic concentration produced in the second case, the iron stopper should be projected from the tube, if not too tightly held within it, at the moment when the core is magnetised.

4. It follows from these effects that, in order to usefully employ tubular electro-magnets, their polar extremities should be provided with iron stoppers of a thickness at least equal to that. By this arrangement an increase of force is obtained which, in telegraphic electro-magnets, may be in the ratio of 25 to 38.

As to the thickness of the tubular cores, this should vary with the force of the current which is to magnetise them. Mr. Hughes found by experiment that, for telegraphic electro-magnets, this resistance should be one-fourth of the diameter of the tube; but the author found, also by experiment, that, in the case of electro-magnets of large diameter, the thickness may be reduced to a greater extent. In the author's "Researches on the Best Conditions for the Construction of Electro-Magnets," p. 112, the following formula is given for the diameter (c_1) of the *tube*:

$$c_1 = c \sqrt[3]{\frac{x^3}{4\,(x-1)}}.$$

Here c is the diameter of a *solid* core capable of being magnetised to saturation, and x the divisor of c which gives the thickness. Now, the value of x, may, without much detriment, be made as high as 7.

(TO BE CONTINUED.)

ON THE SENSITIVE STATE OF VACUUM DISCHARGES.—Part II.

By W. Spottiswoode, D.C.L., LL.D., Pres. R.S., and J. F. Moulton, late Fellow of Christ's College, Cambridge.*

This paper forms a sequel to that published under the same title in the *Phil. Trans.*, 1879. It describes a continuation of the research into the nature and laws of the disruptive discharge, or electric spark. The methods of the earlier paper have been extended, and others adapted to the new circumstances have been devised, in order to carry the investigation into high vacua. In particular, independent sources of electricity have been used for affecting the discharge, whether in the sensitive or in the non-sensitive state; and the results have been confirmatory of the conclusions derived from the more limited means formerly described. Further, the effects of various tubes containing discharges in the sensitive state upon a tube containing a discharge in the non-sensitive state have been observed and compared; and the tube so used as a test has been called the standard tube, and the method of its use the standard tube method. By this means, principally, the laws of the discharge in comparatively moderate vacua have been extended to high vacua.

In the higher vacua, the phenomena of molecular streams, and the phosphorescence consequent on them, that have been studied and described by Mr. Crookes, present themselves. These derive great importance for the purposes of the present paper from the fact that in high vacua the ordinary luminous discharge becomes so feeble in appearance that it is often difficult to observe. Under these circumstances the phosphorescence, which like the ordinary luminous effects may exist either in a sensitive or in a non-sensitive state, forms the best index of what is going on within the tube. Much information as to the nature and procedure of the discharge may be derived from the mode of interference of one molecular stream with another, from the direction and character of shadows cast by these streams, and by a form of interference which has here been called that of virtual shadows.

The conditions of pressure and of electrical violence, under which phosphorescence is produced, have been carefully studied; and it has been found that, with a suitable adjustment of the discharge, the phenomena are not confined to high vacua, but can be obtained under pressures much exceeding those of ordinary vacuum tubes. The phenomena of these molecular streams have also been compared with those exhibited by the projection of finely divided solid conducting matter when heaped up over the negative terminal, with the view of ascertaining the nature of the phenomenon and the position in the discharge.

At the close of the paper the authors have discussed some of the general conclusions which they think may be fairly drawn from their present researches. First, as to the relative order of magnitude of the time-quantities entering into the discharge, *e.g.*, the times occupied by the discharge of positive or negative electricity, or of molecular streams, in leaving a terminal; the time occupied by the same elements in passing along the tube, &c. Secondly, as to the durational character of the negative as compared with the positive discharge, which appears to increase with the degree of exhaustion. Thirdly, as to the mode of formation of the positive column; and fourthly, as to the relation of the molecular streams to the discharge proper.

But for the details of these conclusions the reader must be referred to the paper itself.

* Abstract of paper presented to the Royal Society.

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THE ELECTRICIAN.

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THE NOMENCLATURE OF ELECTRICAL UNITS.

It is some years since the British Association Committee concluded their labours on the question of units, and we fondly believed that they had left no point unsettled or in such a state as to lead to the slightest misunderstanding. Lately, however, we have been a little puzzled on the subject of "Farads," "Webers," and "Oersteds." At first we thought this was due to our own ignorance, but finding that others also were unsettled in their mind as to the proper functions of these names, we have gone more closely into the question, and find there is some reason for confusion.

On taking up Messrs. Clark and Sabine's work (1871) we find, however, that the British Association Committee are not responsible for the nomenclature about which we are writing; thus it is stated in the preface that "The names *farad*, *ohm*, and *volt* have not been formally sanctioned by the committee appointed to report on units by the British Association; they have, however, come into hourly use among the members of the committee, and among electricians at large, and are doubtless destined to be adopted universally." The committee are, therefore, not responsible for any of the names, and indeed in the reports of the committee as reprinted, with Mr. Fleeming Jenkin's Cantor Lectures, by Spon in 1873, we can find no mention of any other name than an "Ohmad" standing for resistance, but as the book has the exasperating fault of not having an index, we cannot be certain of this.

Still, no one doubts that the name of the illustrious professor of Nuremburg, "Ohm," stands for the unit of resistance and nothing else, and with equal undisputed clearness we have the name of the celebrated Volta—mangled, it is true, by the suppression of the final a—as the unit of electromotive force. When we go further we have the first portion of the immortal Faraday's name doing duty both for capacity and quantity, but blending into a "Weber" in a very curious way, as we shall presently show.

Thus taking Clark and Sabine in the preface, we have "The word *veber* has also been introduced to express the unit of quantity of electricity, or that which passes through one *ohm* in one *second* with a difference of tension of one *volt*." Here, then, *veber* stands for unit of quantity, and on page 4 it is stated, in spite of the preface stating that the British Association had not sanctioned these names, that this is the British Association unit of quantity in these words:—"*Quantity*.—The B. A. unit of quantity is called a *veber*, and represents that quantity of electricity which flows through a circuit having an electromotive force of one *volt* and a resistance of one *ohm* in one second." Then as regards capacity Clark and Sabine state:—"The B. A. unit of capacity is called a Farad. The capacity of any electrified body is that *quantity* of electricity which it contains when the inductive surfaces have a difference of potential of one *volt*." Here, then, again, the British Association is given as the authority for the name. Turning now to Mr. Fleeming Jenkin's excellent little work we have "the unit of capacity is termed a *farad*." So far we get Clark and Sabine and Jenkin going together, but next we get "The unit of quantity is that which will be contained in one farad when electrified to the potential of one volt; it has no distinctive name, and may be called a farad also." Then there is a foot note saying, "Mr. Latimer Clark calls it a *Weber*." So here we have the unit quantity called both a *farad* and a *weber*. Professor Everett, in his "Units and Physical Constants," says, in allusion to the unit of quantity, "It is called a *Weber*." Preece and Siveright, in their "Telegraphy," state also, "The unit quantity of electricity in general use has been called a *Weber*."

Now, turning to the unit of current and taking up Clark and Sabine, we find (page 3):—"*Current*.—The B. A. unit of current is equivalent to *one veber per second*; or the current in a circuit having *an electromotive force of one volt and a resistance of one ohm*." Here, again, the British Association is made the authority for stating that the unit of current is a weber per second, but no name is given to it. Fleeming Jenkin states, page 161 (first edition), "The unit of current is one farad per second; it is one tenth of the absolute unit of current, and is frequently termed for brevity a farad, just as, in speaking of velocity, we often speak of a velocity of 100 feet, the words per second being understood."

Here in defining current it will be observed "farad" (for unit of quantity) is used, when Clark and Sabine used "*Weber*." Professor Everett says, "The practical unit of current is the current due to an electromotive force of one volt working through a resistance of one ohm. It is called a current of one weber per second." Taking, now, Mr. Schwendler's "Instructions for Testing," Calcutta, second edition, we find (page 5) "The 'Weber,' or unit of *quantity*," &c.; "The 'Oersted,' or unit of *current*," &c.; "The 'Farad,' or unit of *capacity*," &c.; and "An E.M.F. of one volt acting through a resistance of one ohm produces a current of one

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Oersted. A current of one Oersted conveys a quantity of one Weber per second. A conductor of one Farad capacity, charged to the potential of one volt, contains a quantity of one Weber." In a foot-note in Mr. Schwendler's second volume, London, second edition, he states that the late Mr. Brough proposed the "Oersted."

Here we have the new term "Oersted" introduced as a name for what Mr. Jenkin calls a Farad per second, or simply a Farad, and what Mr. Clark and Professor Everett call a Weber per second. Preece and Siveright do not mention the unit of current. To sum up, therefore, according to the authorities we have quoted, we have standing for quantity the terms "Farad" and "Weber," and for current "Farad per second," "Weber per second," "Farad," "Weber," and "Oersted," whilst "Farad" stands also for capacity.

The word *Weber*, without any "per second" attached, seems to have been gradually more and more used as the term for the unit of current. It is employed by the Post Office (or rather the "milli weber" is) in all the official forms as the unit of current, and we understand that it is used all over America. Doctor Hopkinson uses it in his paper on electric light.

There is evidently, therefore, from what we have shown, quite enough crossing of terms to confuse the student even if there is not enough to lead to mistakes amongst those who know something of the subject, and the question remains what can be done to clear the horizon, and arrive at some definite nomenclature? If we kept "Farad" for capacity, and "Weber" for current, we might find another name for quantity. At first sight it may appear that we need only have one term for quantity and capacity, just as a pint measure contains a pint of liquid, and, therefore, we use no separate term for these two units; but the pint measure can only contain a pint of liquid, and nothing more, whereas a condenser having a capacity of a "Farad" may contain any quantity of electricity, and, therefore, we think it is necessary to have a distinctive name for the unit of quantity from the unit of capacity. The next point is having a name for unit of quantity. Is it necessary to have a separate name for unit of current, or merely give it the name of the unit of quantity, and assume the words "per second" are understood? We would remark here that in merely writing there could be no mistake if it is once agreed that "per second" is understood when using the unit of quantity for unit of current, because we should generally speak of "a quantity" of so many webers, or "a charge" of so many webers, or "a current" of so many webers, but it obliges us always to use these words "quantity of," "charge of," or "current of," before the numerals and in all headings of forms, whereas in the case of electromotive force or resistance, it is quite unnecessary to put E. M. F. over volts, since volts can express nothing else, or to put resistance over ohms since ohms can express nothing else. We are of opinion, therefore, that there is some slight advantage in having a separate term for unit of current, but whether this shall be attained by introducing Mr. Brough's term, the "*Oersted*," or by keeping *Weber* for current, and giving the unit of quantity a new name is another question. We should be very careful about introducing new terms, and it is not at all certain in this case whether the advantage gained is worth the change. If it is not, then we would advise that *Farad* be retained for capacity, and that *Weber* do duty both for quantity and for current. We may, then, speak of a condenser of one farad being charged with a quantity of one weber, and also write of a current of one weber. But we must then be careful to put "quantity" or "current" before the term "Weber" to denote which we allude to. It would be well if a committee of the Society of Telegraph Engineers or British Association should be appointed to discuss these points, and decide authoritatively the exact nomenclature to be employed.

ON THE EFFICIENCY OF EDISON'S ELECTRIC LIGHT.

By Professor H. A. Rowland of the Johns Hopkins University, and Prof. G. F. Barker of the University of Pennsylvania.

The great interest which is now being felt throughout the civilized world in the success of the various attempts to light houses by electricity, together with the contradictory statements made with respect to Mr. Edison's method, have induced us to attempt a brief examination of the efficiency of his light. We deemed this the more important because most of the information on the subject has not been given to the public in a trustworthy form. We have endeavoured to make a brief but conclusive test of the efficiency of the light, that is, the amount of light which could be obtained from one horse-power of work given out by the steam engine. For if the light be economical, the minor points, such as making the carbon strips last, can undoubtedly be put into practical shape.

Three methods of testing the efficiency presented themselves to us. The first was by means of measuring the horse-power required to drive the machine, together with the number of lights which it would give. But the dynamometer was not in very good working order, and it was difficult to determine the number of lights and their photometric power, as they were scattered throughout a long distance, and so this method was abandoned. Another method was by measuring the resistance of, and amount of current passing through a single lamp. But the instruments available for this purpose were very rough, and so this method was abandoned for the third one. This method consisted in putting the lamp under water and observing the total amount of heat generated in the water per minute. For this purpose, a calorimeter, holding about 1¼ kil. of water, was made out of very thin copper; the lamp was held firmly in the centre, so that a stirrer could work around it. The temperature was noted on a delicate Baudin thermometer graduated to 0°·1 C.

As the experiment was only meant to give a rough idea of the efficiency within two or three per cent., no correction was made for radiation, but the error was avoided as much as possible by having the mean temperature of the calorimeter as near that of the air as possible, and the rise of temperature small. The error would then be much less than one per cent. A small portion of the light escaped through the apertures in the cover, but the amount of energy must have been very minute.

In order to obtain the amount of light and eliminate all changes of the engine and machine, two lamps of nearly equal power were generally used, one being in the calorimeter while the other was being measured. They were then reversed and the mean of the results taken. The apparatus for measuring the light was one of the ordinary Bunsen instruments used for determining gas-lights, with a single candle at ten inches distance. The candles used were the ordinary standards burning 120 grains per hour. They were weighed before and after each experiment, but as the amount burned did not vary more than one p. c. from 120 grains per hour, no correction was made.

As the strips of carbonized paper were flat, very much more light was given out in a direction perpendicular to the surface than in the plane of the edge. Two observations were taken of the photometric power, one in a direction perpendicular to the paper, and the other in the direction of the edge, and we are required to obtain the average light from these. If L is the photometric power perpendicular to the paper, and l that of the edge, then the average λ will evidently be very nearly

$$\lambda = \mathrm{L}\int_{\frac{1}{2}\pi}^{0} \cos a \sin a \, da + l\int_{\frac{1}{2}\pi}^{0} \sin^2 a \, da,$$

$$\lambda = \tfrac{1}{2}\mathrm{L} + \frac{\pi}{4} l.$$

In the paper lamps we found $l = \frac{1}{2}$ L nearly; hence $\lambda = \frac{3}{4}$L nearly.

The lamps used were as follows:—

No.	Kind of carbon.	Size of carbon.	Approximate resistance when cold.
580	paper	large	147 ohms.
201	"	"	147 "
850	"	small	170 "
809	"	"	154 "
817	fiber	large	87 "

The capacity of the calorimeter was obtained by adding to the capacity of the water the copper of the calorimeter and the glass of the lamp and thermometer. The calorimeter and cover weighed 0·103 kil. and the lamps about 0·035 kil.

First experiment, No. 201 in calorimeter and No. 580 in pho-

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tometer; capacity of calorimeter = 1·153 + ·009 + ·007 = 1·169 kil. The temperature rose from 18°·28 C. to 23°·11 C. in five minutes, or 1°·75 F. in one minute. Taking the mechanical equivalent as 775, which is about right for the degrees of this thermometer, this corresponds to an expenditure of 3,486 foot pounds per minute. The photometric power of No. 580 was 17·5 candles maximum, or 13·1 mean, λ.

When the lamps were reversed, the result was 3,540 foot pounds for No. 580, and a power of 13·5 or 10·1 candles mean.

The mean of these two gives, therefore, a power of 3,513 foot pounds per minute for 11·6 candles, or 109·0 candles to the horse-power.

To test the change of efficiency when the temperature varied, we tried another experiment with the same pair of lamps, and also used some others where the radiating area was smaller, and, consequently, the temperature had to be higher to give out an equal light.

We combine the results in the following table, having calculated the number of candles per indicated horse-power by taking 70 per cent. of the calculated value, thus allowing about 30 per cent. for the friction of the engine, and the loss of energy in the magneto-electric machine, heating of wires, &c. As Mr. Edison's machine is undoubtedly one of the most efficient now made, it is believed that this estimate will be found practically correct. The experiment on No. 817 was made by observing the photometric power before and after the calorimeter experiment, as two equal lamps could not be found. As the fiber was round, it gave a nearly equal light in all directions as was found by experiment.

Lamps used in		Photometric power		Capacity of Calorimeter in pounds.	Rise of temperature in degrees F.	Energy per minute in foot pounds.	Mean number of candles per horse-power of electricity.	Mean number gas jets of 16 candles each per horse-power of electricity.	Mean number of gas jets per indicated horse-power.
Calorimeter	Photometer	Measured perpendicular to paper, L.	Average, λ						
201	580	17·5	13·1	2·57	1°·75	3486·	109·0	6·8	4·8
580	201	13·5	10·1	2·82	1°·62	3540·			
580	201	38·5	28·9	2·74	2°·44	5181·	204·3	12·8	8·9
201	580	44·6	33·5	2·76	2°·29	4898·			
850	809	19·0	14·3	2·81	1°·14	2483·	133·4	8·3	5·8
809	850	12·2	9·2	2·79	1°·54	3330·			
	817		17·2	2·73	1°·28	2708·	209·6	13·1	9·2

The increased efficiency, with rise of temperature, is clearly shown by the table, and there is no reason, provided the carbons can be made to stand, why the number of candles per horse-power might not be greatly increased, seeing that the amount which can be obtained from the arc is from 1,000 to 1,500 candles per horse-power. Provided the lamp can be made either cheap enough or durable enough, there is no reasonable doubt of the practical success of the light, but this point will evidently require much further experiment before the light can be pronounced practicable.

In conclusion, we must thank Mr. Edison for placing his entire establishment at our disposal in order that we might form a just and unbiased estimate of the economy of his light.—*American Journal of Science.*

THE EDISON LIGHT.

A Criticism of the Article in the "American Journal of Science"—What it is that Electricians want to Know?

(To the Editors of the *Evening Post.*)

In the *Evening Post* of Saturday last, referring to the publication in the *American Journal of Science* of the result of certain tests of the Edison electric light, you say:—"The examinations . . . have been elaborate, and the results are open to scientific inspection and criticism in the tables of formulas and the propositions and corollaries deducible therefrom." It appears to me, on the contrary, that the article in question is rather more remarkable in respect to what it fails to say than otherwise, and that it avoids with considerable skill the real point in question, the practical and commercial value of Mr. Edison's system of lighting.

It is well known to those who are even tolerably familiar with the subject that electric lighting by incandescence is by no means a new thing; and although it may, perhaps, not be so well known, it is equally true that the subdivision of the current, the automatic regulation of the light, its maintenance with absolute steadiness for months at any required degree of intensity—all this had been accomplished long before Mr. Edison attacked the problem. The problem remaining to be solved concerned solely the economical production of the light.

Now, what the public would like to know is simply this: First, What quantity of electricity per second is required to produce in the lamp an electric light having the photometric value of say ten standard candles? Second, What is the cost of generating that quantity of electricity and of conveying it to the point where it is to be converted into light?

Any physicist can answer these questions with perfect accuracy provided the proper data are placed in his hands, and moreover such data can be obtained by simple and direct methods in every day use. There is no occasion for any mystery about it.

The illuminating power of any electric light or any number of them is readily ascertainable by the photometer. The amount of electricity in vebers (units of current) per second, passing through the conductor which supplies the lamp, can be measured with the utmost ease by means of a tangent galvanometer, an instrument which is among the essential appliances of every working electrician. The electrical resistance of the three parts of the conducting circuit, namely, the generator, the leading wires and the lamp, may be ascertained by the same instrument with facility and accuracy. The horse-power absorbed in driving the generator is measurable by a dynamometer.

Now it appears to me, and I think most electricians will be willing to agree with me, that all that we need to be able to form a judgment of the practical value of the light is a statement of the following facts:—

1. Horse-power required to drive the generator.
2. Electro-motive force of the generator.
3. Resistance of the circuit.
   a. Of the generator.
   b. Of the leading wires.
   c. Of the lamp.
4. Actual current in vebers per second required to produce light.
5. Value of light so produced in standard candles.

This will tell us exactly what is put into the system and what can be got out of it in plain figures, which it is not possible to do from the article in the *American Journal of Science*, as the very essential point of the resistance of the circuit is carefully left out of the calculation.

It certainly tends to excite a mild form of surprise, to say the least, when we find in the article referred to such statements as these:—

"The dynamometer was not in very good working order, and it was difficult to determine the number of the lights and their photometric power, as they were scattered throughout a long

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distance, and so this method was abandoned. Another method was by measuring the resistance of and amount of current passing through a single lamp. But the instruments available for this purpose were very rough, and so this method was abandoned," &c.

An establishment like that at Menlo Park certainly ought to be provided with something better than "very rough" instruments for measuring electric currents.

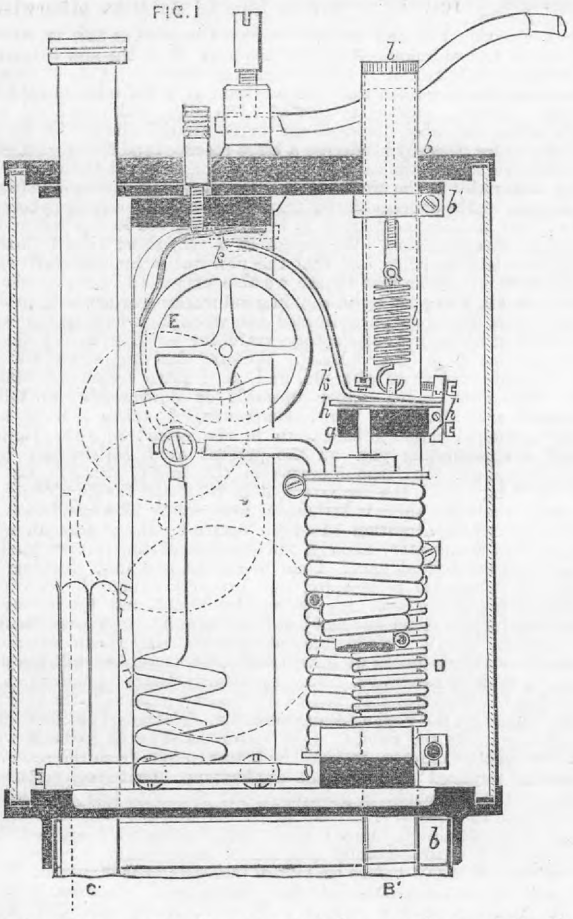
The electricians of the country will, I think, await with some interest the publication of authentic measurements and particulars in relation to the above-mentioned points.

Elizabeth, N. J., March 30, 1880. F. L. P.

CROMPTON'S ELECTRIC LAMP.

In accordance with the promise given in our article on Mr. Alexander Siemens' paper read before the Society of Telegraph Engineers, we herewith illustrate Mr. Crompton's lamp, which excited a considerable amount of interest when exhibited before the society. We are informed that this lamp has already been introduced to a considerable extent in the North of England; for instance, six of the lamps are to be used in lighting the great station of St. Enoch, at Glasgow, while upwards of thirty are in use in various iron-works, dye-works, glass-works, &c. The machine used with these lamps is, with one or two exeptions, the continuous current Gramme.

FIG. I



The inventor, as all who attended the meetings of the Society of Telegraph Engineers are aware, claims for his lamp a steadiness in burning, and freedom from liability to flicker, hiss, or go out, superior to any other lamp of this class. In considering and comparing electric lamps, it is always necessary to remember they are of three kinds, those regulated by mechanism, those of the Jaclochkoff type, and those depending on incandescence. The various types will probably be ultimately found to have their special advantages under special conditions, and each be used where its advantages are greatest. For example, if expense forms no part of the question, it will, perhaps, be judicious to introduce the incandescent lamp, but as this will generally form one of the most important items of consideration, the claims of the other lamps will be duly considered.

Mr. Crompton contends that with the exception of his own, all regulator lamps fail in delicacy of feed movement. The result of this irregularity is that the distance between the carbon points is a variable instead of a constant quantity, causing also a variation in the form of point, and ringing a series of changes in the colour of the light, from pure white when the points are at their normal distance apart to a purple or bluish light as the distance increases. As the principal current moves through the circuit of least resistance there will be a continual play of light around the carbon points, the greatest intensity now here now there, and these faults have been generally attributed to the dynamo machine or the steam engine. Mr. Crompton's contention is they are due to the regulating mechanism. The makers of engines can be relied upon to give what they promise, to furnish a speed that will rarely vary more than 5 per cent. from the normal, and there is no difficulty in getting sufficiently good carbons.

Promptness of action is obtained in this lamp by reducing the weight of the brake mechanism which checks the advance of the positive carbon rod to a few grains, thus giving the varying strength of the magnetic field of the lamp magnets the smallest possible work to do.

The upper part of the lamp which contains the mechanism consists of a circular top and a circular bottom plate, separated by the side plates, carrying a train of wheels. Below the bottom plate is a large brass tube varying in length according to the length of carbon required; in a 9 hours lamp it is about 18". The tube can be suppressed in the smaller lamps, as it simply forms a guide for the long carbons, which are made to slide through a platinum contact piece at the bottom of the tube.

Fig. II. is a plan of the mechanism of the lamp. Fig. I. a section.

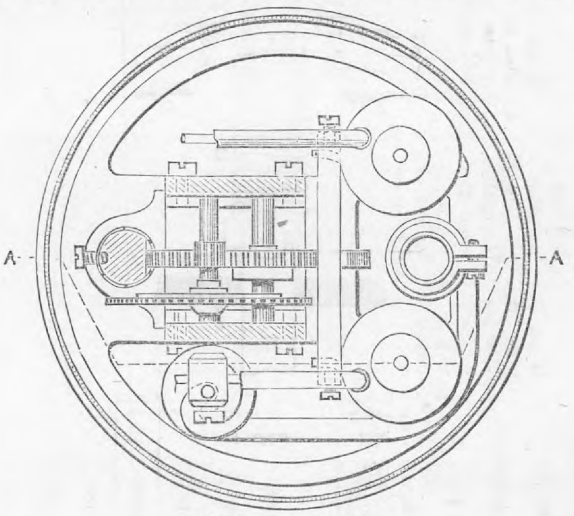


FIG. 2 PLAN

Fig. IV. is a section through the lower portion of the carbon holder. More in detail, B is the lower carbon. B' the carbon holder, adjustable in every direction, as will be seen from Fig. IV. The upper end of the carbon holder slides through holes in the top and bottom plates as b, b_1, the length of slide being regulated by the clamping collar b'. When the lamp is not working this collar is pressed against the underside of the top plate by a spiral spring, D. C is the upper carbon, C' the holder. This is of brass, the weight of which supplies the motive power to advance the carbon, the descent being checked by a rack cut on it, the teeth of which engage with a train of wheels. On the axis of the last wheel of this train, E, are two vanes or flies and a brake-wheel. One revolution of this brake-wheel allows the rod to descend $\frac{1}{10}$ of a millimetre. The vanes retard the speed of the wheelwork to a sufficient extent to render the descent of the holder very regular. G G are the controlling electro-magnets, through the coils of which the current passes when the lamp is at work, so that on commencing to work the armature g is drawn into contact with the cores and depresses the lower carbon holder, B', which is firmly fixed to it, and this position is retained so long as the strength of the current is sufficient to enable the magnets to overcome the pull of the spring D. On the upper surface of the armature is mounted the soft iron, h, which is hinged to h'. The soft iron h carries a curved brake-piece on an arm, K K', adjusted and shaped so that when the armature g rests upon the cores, it acts as a brake on the fly-wheel and stops the descent of the upper carbon. The piece h is held away from the armature by the regulating spring, l, regulated by the screw, l', to such a tension that when the lamp burns under normal conditions the brake is applied. If, however, the current is weakened the spring acts, and the brake is released until the balance is re-established, that is till the attraction of the magnet overcomes the force of the spring. When all the parts are in good order this brake will rise and

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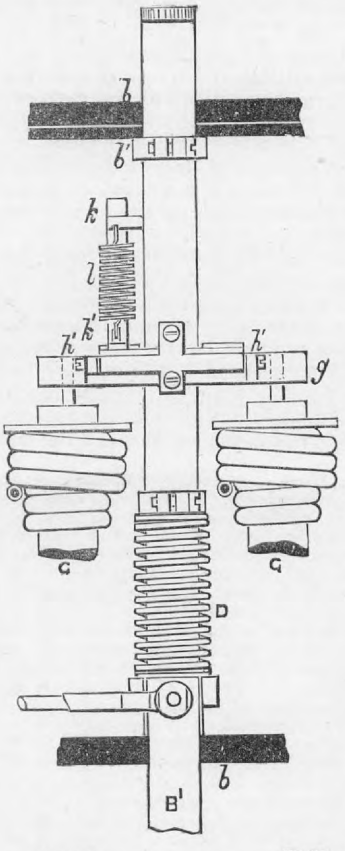
fall eight or ten times for each revolution of the brake wheel, or, as the inventor says, it is always on the move. The portion of the mechanism that moves during the feeding of the lamp is this light plate and curved arm, which, being pivotted on a pair of hard steel points, requires no oiling, and is, therefore, not so liable to become clogged. It is in the few parts moved that the

FIG. 3



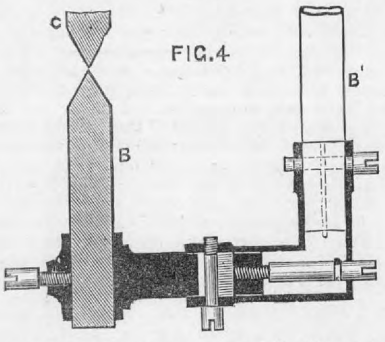


FIG. 4

inventor claims to have overcome many faults met with in other regulator lamps. The wearing parts are lessened, hence the liability to get out of order is greatly diminished, as is the first cost, as well as the cost of cleaning and attention. The parts are less than half the number in the Serrin, and less than those in the latest pendulum lamp of Siemens.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY (LIMITED).

The thirteenth ordinary general meeting of the above Company was held on the 21st inst., at the City Terminus Hotel, Cannon-street, under the presidency of Mr. J. Pender, M.P.

The SECRETARY read the notice convening the meeting, and the minutes of the twelfth ordinary general meeting, and of the extraordinary general meeting held immediately after the termination of the ordinary meeting.

The CHAIRMAN: Gentlemen, is it your pleasure that those minutes be signed as correct?

Mr. MARSHALL: I think just before the last meeting closed there was a suggestion made that the dividend should be at the rate of 6 per cent. That was not agreed to, and there was some dissatisfaction expressed. There were three dissentients, but you say that the motion was carried unanimously. That was not so.

The CHAIRMAN: That was after the meeting was over, I think.

Mr. MARSHALL: No, sir.

The CHAIRMAN: Well, we will say with three dissentients, then. Having signed the minutes, with this alteration, he continued. Gentlemen, you have had the report in your hands some days. Will you take it as read, or do you wish it read? [Voices: Take it as read.] Very well, gentlemen, before making a few general remarks I will refer more particularly to the report. The gross receipts for the half year ending the 31st December, 1879, were £165,930, and for the corresponding period of 1878 they were £140,976, showing an increase of £24,954. The expenses for the past half year were £68,683, and for the corresponding period of 1878 they were £71,249, or a decrease of £2,566, caused principally by a reduction in the cost of repairs. The net revenue for the past half year was £97,247, as against £69,726 in the corresponding period of 1878, showing an increase of £27,521. One interim dividend of 1¼ per cent., absorbing £24,968, has been paid for the half year; and it is now proposed to distribute another of like amount on the 22nd inst., leaving, with the balance brought forward from the previous half year, £81,970 for the reserve fund, which now stands at £157,870—equal to about 8 per cent. of the share capital. The amount taken from the reserve fund in 1877—I wish to draw your attention particularly to this remark—for laying the Penang-Rangoon cable was £156,000. If this sum had been raised by 6 per cent. debentures the revenue would have been subjected to an annual charge of £4,000 for interest. The heavy cable repairs which the Company has had to face since the amalgamation—a period of seven years—have cost £155,000. In other words, but for these repairs the shareholders might have had an increased dividend of about 1¼ per cent. If the ship's expenses while in harbour—which also form part of the cost of repairs—amounting to £63,000, are included, the total cost would be £218,000, or about 1½ per cent. per annum since the formation of the Company. The duplicate Australian cable has been successfully completed since the last meeting. It is laid direct from Singapore to Banjoewangie, thereby avoiding the Java land lines, by which a considerable saving of time in transmission has been effected, and increased accuracy obtained, as the messages now pass entirely through English hands. A continuous day and night service was at the same time established with Australia, which has given great satisfaction to the telegraphing public, as we are now able to deliver telegrams in London from Australia, beating the sun by four or five hours, or, allowing for the difference of time between the two countries, messages now average about six hours in transmission. Although the interest on the new capital raised for this cable is fully met by the Government subsidy of £32,400 per annum, it must not be forgotten that the addition of 2,500 miles of cable to the Company's already existing system of 7,369 miles, making a total of about 10,000 miles of cable, imposes an extra annual charge for keeping it in proper order, thereby rendering a large reserve fund the more necessary. The China section of the cable is also now worked night and day, which is adding materially to the traffic of the Company, and giving satisfaction to our customers, the average time of transmission of the messages being three hours. The Manilla concession to which I referred in my last address is in course of completion. We expect in a very short time to learn that the ship has laid the cable, and that the new line is incorporated with our present system. From that source we also expect additional traffic. The cables are all, I am happy to say, in good working order, and probably I have never on any occasion addressed you when the whole system was in a more efficient and more satisfactory state for earning money than it is at the present time [hear, hear]. We are deriving some advantages from the improved state of trade, and, as I have frequently stated, as trade begins to move either upwards or downwards so telegraph companies are affected. Now, gentlemen, I think I have touched on the principal points referred to in the report in your hands, and beyond congratulating you on the present very satisfactory position of the company, the large increase in the traffic, arising, no doubt, from, as I have said, the improvement in trade and the duplication of our system to Australia, there is little more to be said. There is, however, one question to which attention has been drawn by the gentleman who has referred to the minutes, namely, the question of the reserve fund, and I may as well meet it at once. I am bound to say that, looking to the history of submarine telegraphy, our property cannot be considered a secure one unless we have our system duplicated, and the reserve fund sufficiently large to meet any sudden drain upon it. If it were inadequate our property would be a fluctuating one, and I can see no sound ground for stability unless we have a sufficient amount as will enable us to renew our cables if necessary. Now, gentlemen, the one point which I have referred to in support of this, and as illustrating more fully the views I hold on the subject, is the Penang-Rangoon cable. We thought at that time that instead of going to the public for debentures and putting almost a permanent debt on the Company, it would be better to take from the reserve fund the amount required to make that duplication. That received the approbation of the shareholders generally. At the same time, in taking that amount from the reserve fund we weakened our reserves to that extent, and our proposal now is—and I hope that the shareholders will look to steady dividends, to certainty instead of uncertainty—that we should replace that £156,000 before we talk of increasing the dividend. If we go on at the rate we have done this last year it will very soon be replaced, and we shall then have a reserve fund considerably over £300,000. We can then apply a portion of the earnings to increasing that sum, to bring it up probably to half a million, and at the same time give to our shareholders an additional dividend. These are the views which my Board hold; I think they are sound, practical, business-like views, and I am satisfied that it will be of very great advantage to the value of this property in every sense if they are approved of by the shareholders, and carried out by your directors. Now, gentlemen, with these remarks I shall be glad to hear any gentleman's opinion for or against the statement which I have made, and I am hopeful that those who take my view will support it from the body of the meeting. To be in form, I shall, before any shareholder addresses the meeting, move the following resolution:—"That the report and accounts of the directors now submitted be received and adopted, and that a dividend be now declared of 2s. 6d. per share payable on the 22nd inst., making, with the interim dividends already paid, a total of 5 per cent., free of income tax, for the year 1879."

The Right Hon. W. N. MASSEY, M.P., the vice-chairman: I beg to second that motion.

The CHAIRMAN: I am now prepared to hear any one who may have any remarks to make before I put the resolution.

Mr. MARSHALL: While recognising and thanking you for the very lucid

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statement you have made, I wish to say a few words and draw attention to what we were told a few years ago. Then the prospect of an increase in the dividend was held out when the cables were duplicated, but now that they are duplicated we are told to rest and be thankful till we have half a million in store, or some such sum that will ensure the renewal of the cables. It appears from your own statement that there is an increase of £27,000 in the net revenue of the past half year, or say £24,000, as the working expenses have been reduced by some £2,000 or £3,000, which is in itself a very great advantage to the Company. At the same time, I do feel that as we have earned so much more during this half year, the time has arrived when you should increase the dividend to a fair extent, say to 6 per cent. We can well afford that increase. It will only make a difference of £20,000, and we should then still carry the balance of £61,000 to the reserve fund. This is an old question, and has been brought up at every meeting more or less since the various companies have been amalgamated. Taking into consideration the class of property we are in, and the very great risk we run, I think the shareholders should receive a higher dividend than 5 per cent. [hear, hear], and therefore, Mr. Chairman and fellow shareholders, I beg to move that the matter of dividend be referred back to the consideration of the directors with the view to increasing it to 6 per cent. I would also point out that the reserve fund is not £157,000, but £314,000, because we have invested part of it in our duplicate cables, and therefore we stand very much better than appears from the accounts. I beg to move the amendment mentioned.

Mr. MACLAREN SMITH: I second that, and I don't see that the addition of 1 per cent. to the dividend will materially alter our prospect of getting a steady dividend.

Mr. BAINES: I rise for the purpose of supporting the proposal made by Mr. Marshall. I have not heard him make it before, but you will also remember that I have always maintained, on account of the elasticity of the earnings of this Company, that it is quite capable of paying more than 5 per cent., and I think now that we can do what is proposed with safety. I don't wish to go very much into particulars on the present balance-sheet, because on the whole I think it satisfactory to the proprietors, although a little more economy is desirable, but that I leave in the hands of the Board. I have every reason—and most of us have—to know the value of a reserve fund. We do not contest its value, and we admit that it is of service, but there is such a thing as having a reserve fund of too large a character. When it becomes too large I have noticed in one or two instances that it has a tendency to induce directors to engage in speculations of a character not altogether profitable. Looking back, you may remember in other cases how the advantages of a reserve fund have been referred to, and yet the probability is that after a little time you see the business is not so profitable, and away goes the reserve fund, and we have to begin the very nice process of building it up. That is generally done at the expense of the shareholders. I will not say very much more at present; but I think that the shareholders will do well to take into consideration the proposal now made. It is a very moderate one. I would also suggest the propriety of trying to make something like a dividend of 8 per cent. I look forward to the time when this Company ought to pay 8 per cent. I consider, with the chairman, that it is a risky property; yet, taken all in all, there is an elasticity in the revenue which gives it a certain amount of security. I think, looking at its character, that 8 per cent. is not too much to look forward to. On the present occasion I shall content myself with supporting the proposition made by the gentleman on the right, and I think it can be carried out, and to the satisfaction of the shareholders.

The CHAIRMAN: Gentlemen, it is the interest of your directors to manage the affairs of this Company with the view to permanency. The dividends which this Company has paid lately have been steady even during the recent bad times, and our property has been steadily increasing in value. Those who have invested in this Company in the last two or three years are receiving considerably more than 5 per cent. at the present time; those who buy the shares to-day receive more than 5 per cent., and consequently we feel that stability is a most important element in the interest of the large body of shareholders. We have an opportunity of testing the views of a large proportion of our shareholders, and we know from the documents in our hands that they approve of the policy which we have put before you to-day. You cannot have it both ways, gentlemen; you cannot have it out in dividend and in increased value of your shares. You are getting your 5 per cent., but the value of your property has been considerably enhanced during the last two or three years. We want to establish the value of your property on such a firm basis that when we begin to pay an advanced dividend we shall be able to maintain it. If before we get this £156,000 back to the reserve fund, bringing it up to the point I indicated, I don't think our property would be increased in value by increasing the dividend by 1 per cent. to-day. At the rate we are going on now that is not very far distant, and as the reserve fund increases the value of your stock in the market will likewise increase. I must say that I have listened with the greatest possible attention to the gentlemen who have just spoken, and I am quite open to conviction when they can convince my judgment and reason, but I must say that they represent an infinitesimal section of the great body of shareholders, whose interests we, the directors, are bound to protect. I, therefore, cannot consent to any resolution altering the dividend, as suggested by Mr. Marshall. There is another reason, too. If Mr. Marshall had looked at the articles of association, he would have seen that we are prevented from paying any higher divdends than we recommend in our report. But putting aside the legal question, if we could manage to get over that, I say on the highest ground we are bound to go on as we are doing till we replace the £156,000. We are bound to maintain our dividend at 5 per cent. till we have our reserve fund in a position that would enable us, in the event of any emergency, to meet the requirement at once. I hope that Mr. Marshall will not press his amendment at the present time, and I would also appeal to Mr. Baines, whom I have seen on many occasions, and have always listened to with the greatest attention, but I am sure that you will agree with me that the three gentlemen who have spoken to-day represent such a small amount compared with the great amount of capital involved in this Company, that it would not be wise on the part of the Board to listen to the suggestion that has been made.

Mr. NEWTON: I should like to make one or two remarks on the two points just mentioned by the chairman—the proxies and the articles of association. I cannot conceive that it is fair to those who attend this meeting to state that you have such unanimous support, because you have those proxies sent back to you in a most perfunctory manner. I can assure you that I have at this moment in my possession two proxies in a case where I am instructed to vote to the contrary, and I shall not be able to use them, because they are made out in the name of my opponent. That shows you how proxies are made up. The shareholders are requested to fill them with certain names, and the proxies sent to the directors in the present case are no criterion of any desire on the part of the signatories against an increased dividend. I cannot agree with the amendment proposed, because it is illegal; but it is illegal because of our articles of association, which I consider one of the most infamous documents ever formed. The articles are really a disgrace to an honourable board of directors [the chairman dissented]. Most decidedly they are, sir. Therefore I don't like a resolution of this kind to be balked by a reference to proxies and articles of association. I will just put my case. It is my interest that 5 per cent. only should be paid, as I have only a small interest in the ordinary shares, while I and my family are considerably interested in the debentures of the company, but I don't think that those shareholders who do not see fit to put by for their posterity should be dealt with as the chairman proposes. They must be allowed to be the best judges as to whether the future should take care of itself or not. I think it is also a strong argument in favour of increasing the dividend, that instead of receiving 1¼ per cent. per quarter, they should receive 1½. In periods of prosperity—whether as regards shareholders or not—if there are periods of prosperity people spend more than in periods of adversity. But we have gone through periods of adversity in the last two or three years, and have had 5 per cent. We have now more prosperous times. I protest against these accounts, showing that we have only £157,000 of reserve fund. I protested against the same thing in the Anglo-American Company, with the result that now every year they show what the reserve fund is in, and our own reserve fund should also be fully stated, and we should then know what we have got. I hold that in such a period of prosperity we should participate to the extent of ¼ per cent., and that the ¼ per cent. should be added, if not ½ per cent., to the second quarter of the half year. You would then be able to go on building up the reserve fund.

Mr. GRIFFITH: There is no doubt that there is great force of argument in the recommendation of the chairman, that permanency and stability are great advantages in any institution; and he tells us that the Board have the power to declare any dividend they please. I think there is a means of avoiding that difficulty. We can move an amendment to the report, but I don't propose that. I think that unity is better, and that we should look at the question on the ground of what will promote the benefit of the Company in the future. Our chairman tells us that it is exceedingly important that we should have a reserve fund of £300,000, but it does not follow that the whole of that reserve fund should come from the profits of one half year. Let us proceed slowly and steadily, and restore it to what it was before. It seems to me that we are thinking too much of stability, and are not making the best use of the capital we possess. I admit that it is a difficult question to say what is capital and what is the legitimate profit to be derived from that capital. We find accountants and lawyers and others differing on that question, but I think we may say that when you find that you keep the stock and plant of the Company in useful and workable condition, and find that it is so thoroughly efficient as described in the chairman's opening speech—then I think we may say that our plant is in a good condition, and that there is no great risk of allowing it to continue in that state. We don't wish to take up any hostile position against the Board—we see the force of their arguments but not of their application. We know they have great ability and a great amount of responsibility committed to their charge. Australia excites ambition, but it is not our interest to supply every place with a new telegraph, but to render what we have safe and stable. I think we might accept the balance-sheet of our Board, but I think if they would accept the suggestion of the shareholders, which seems unanimous, and increase the dividend, it might be done. They might say a dividend of 5 per cent. with a small bonus, and in that way we should be able to accept the balance-sheet; to admit all the views of the Board, and unity would prevail.

Mr. MARCUS: I beg to offer a recommendation which, I hope, will meet the views both of the Board and of the shareholders—that is, that we pass the accounts for 1879 as we find them, and that the shareholders recommend the directors in the ensuing quarter, or in the ensuing half year, to pay an increased dividend if the profits or prospects of the Company will permit, because independently of the accounts rendered up to the end of 1879 we have about £80,000 or £90,000 besides—that is, the earnings from the 1st January up to the present time, so they can pretty well judge from the four months that have elapsed of the present year, whether it is likely they can pay an increased dividend. If any one will second that proposition, I think it will meet the views both of the directors and of the shareholders.

The CHAIRMAN: Gentlemen, your directors are just as anxious to have harmony and unity between themselves and the general body of the shareholders as the shareholders themselves can be. At the same time we are in a better position to judge as to what is the best policy to be pursued in the interests of the great body of the shareholders. We have no personal interests to serve by this. We have to look to the interests of the shareholders as a body. Now, just think for one moment. We have got 3,000 shareholders. How many shareholders are represented at this meeting to-day? I don't suppose there are more than sixty people here. We are bound to represent the great body of the shareholders, and if a majority approve of our policy we are bound to carry out that policy. Mr. Newton has made some rather strong remarks as to the articles of association, but he knew very well what they were from the beginning, and he has made remarks which I am perfectly certain will, when reported and circulated among the great body of shareholders, not induce them to leave their interests in Mr. Newton's hands. As to Mr. Griffith, he has made a very quiet statement, as he always does on these occasions, but I think that Mr. Griffith has not sufficiently carefully studied the report. I don't think he has looked at both sides of the report. I don't believe that Mr. Griffith supposes that because we have ships and other property we could meet any emergency or lay a cable. Such property is part of our plant—that which is necessary to carry on our work. Therefore Mr. Griffith must be well aware that the only amount of money we have to deal with in case of any breakage is the amount of money we have, either in securities, which can

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be converted into money at a moment's notice, or the cash we have at the bank. A telegraph is uncertain property. A cable may be in perfect order to-day, as I am speaking, and to-morrow we may hear of a broken cable, which may cost a considerable sum to put it in order. I have told you that from the beginning of this Company we have paid £218,000 in repairs. That is a very large sum of money. It may be necessary to go on doing that, and surely we should be wrong, as prudent men, not to keep sufficient money under our control to make these repairs as the necessity for doing so arises. I think what we have put before you is not unreasonable. As to the suggestion made by Mr. Marcus, I am quite prepared when I return to our Board to discuss this question with them. We have a certain expression of opinion here to-day, but I am bound to say that that expression of opinion is only from a small portion of the shareholders, and that we should require an expression of opinion from a much larger body of the shareholders. With these remarks I place the resolution before the meeting, and then, if any one chooses to move a recommendation to the Board, that an increased dividend should be paid in future, we can consider it.

Mr. MARSHALL: Then I will withdraw my motion till the balance-sheet is passed.

The CHAIRMAN: Very well. Then those in favour of the resolution please hold up their hands. To the contrary. Carried unanimously, I think.

Mr. MARSHALL: Then I now propose that the directors take into consideration this matter, with the view of increasing the dividend.

The CHAIRMAN: We have no objection to that being moved, but will you put it in proper order? In the meantime we can go on with some of the other business. The next resolution I have to propose is "That Mr. F. A. Bevan, who now retires by rotation, be and is hereby re-elected."

Sir JAMES ANDERSON: I beg to second that.

Mr. MARSHALL: I only wish to state that Mr. Bevan is a director of twelve companies.

Mr. BEVAN: That is quite a mistake.

Mr. MARSHALL: Three, then.

The CHAIRMAN: We all know the position that Mr. Bevan occupies in the commercial world. We know that his name is a tower of strength, and no man attends this Board more carefully than Mr. Bevan. All in favour of his re-election please signify it in the usual manner. To the contrary. Carried unanimously. The next resolution is: "That Mr. C. W. Earle, who now retires by rotation, be and is hereby re-elected."

Mr. W. M'ARTHUR, M.P.: I have much pleasure in seconding that.

The CHAIRMAN: Those in favour of the resolution. To the contrary. Carried unanimously. The next resolution is——

Mr. HORA: I have great pleasure in proposing that "Mr. Henry Dever and Messrs. Quilter, Ball, and Co. be and they are hereby appointed auditors to the Company for the ensuing year at the remuneration of £50 each."

Mr. DONALDSON: I beg to second that.

The CHAIRMAN read the motion, and said: Those in favour of the resolution. To the contrary. Carried unanimously. Now, gentlemen, if Mr. Marshall's recommendation is properly drawn out——

Mr. BAINES: There is one question I should like to ask. I see that Baron d'Erlanger has retired from the direction. Will that alter the remuneration the Board receives?

The CHAIRMAN: I think we have had on some previous occasions an expression of opinion that we had more directors than was necessary. I then stated that whenever there was an opportunity of a director retiring we would avail ourselves of that opportunity to reduce the amount of the Board's remuneration by the amount that that director received [hear, hear].

Mr. MARSHALL: I beg to move "That the directors be recommended in future to take into consideration the receipts, with a view to increasing the dividend."

Mr. SMITH: I beg to second that.

The CHAIRMAN: It has been moved by Mr. Marshall, seconded by Mr. Smith—"That the directors be recommended in future to take into consideration the receipts with the view to increasing the dividend." Those in favour of that motion will please hold up their hands [Voices: All, all]. Well, gentlemen, there is no one that will rejoice more than I to see our dividends increase, but I rejoice more to see them increase upon a foundation which makes that increase permanent. That finishes our business.

Mr. MARSHALL: I have great pleasure in proposing a hearty vote of thanks to the chairman.

Mr. BAINES: And I beg to second the motion, and to assure him that, notwithstanding what has been said, there is no ill feeling.

The resolution was carried unanimously.

The CHAIRMAN: I am very much obliged to you, gentlemen. I believe that we are all looking forward to the same result, and I only hope that we shall be able to realise it some day.

The proceedings then terminated.

NEW PATENTS, 1880.

1397. ELECTRIC LAMPS.—*(A communication).—C. D. Abel.*
1407. ELECTRIC CONDUCTORS.—*O. Heaviside.*
1475. TELEGRAPHIC CABLES.—*(A communication).—F. Wirth.*

ABSTRACT OF PATENT.

3393. TELEPHONES, *P. S. Justice.—Dated 23rd August*, 1879.—*(A communication).* 6*d.*

This consists in holding by mechanism the carbon or other imperfectly conducting medium in the transmitting instrument regularly under pressure, and in causing the action of the diaphragm under the impulses of the sound waves to vary the pressure thus regularly applied, whereby the resistance of the carbon can be regulated at will, and greater sensitiveness and scope of the electrical undulations be produced. The vibrations of the diaphragm are caused to act through intermediate mechanism, whereby the motion of the diaphragm is exaggerated and greater effect produced through the carbon or other medium.

TELEGRAPH SHARE LIST.

COMPANIES.	CLOSING PRICES APRIL 21.		BUSINESS DONE WEEK ENDING APRIL 21. Highest.	Lowest.
Anglo-American Ordinary	60⅛,	1	60⅞	59
Do. "B"	89¾,	90¼	90½	88¾
Do. "A"	33¾,	4¼	34⅞	33½
Brazilian	7 13-16,	15-16	8	7 13-16
Cuba	9½,	10	10	10
Do. Ten per Cent. Pref.	16⅛,	⅜	16½	16½
Direct Spanish	1¾,	2¼	—	—
Do. Ten per Cent. Preference	10½,	11	—	—
Direct United States	11⅜,	⅛	11⅓	11¼
Eastern x d 15 April	8 15-16,	9 1-16	9 3-16	9
Do. Six per Cent. Deb... x d 7 April	102,	4	102½	102¼
Do. Five per Cent. do.	102,	4	—	—
Do. Six p Ct. Preference. x d 9 April	12¼,	½	12⅝	12¼
Eastern Extension	9 1-16,	3-16	9¼	9⅛
Do. Six per Cent. Deb.	106,	8	108	108
German Union	8¾,	9¼	9⅜	9⅛
Globe Telegraph & Trust..x d 15 April	5⅞,	6	6	5¾
Do. Six p Ct. Preference. x d 15 April	11 9-16,	11-16	11¾	11½
Great Northern	9¾,	10	10	9¾
Indo-European	24,	5	—	—
Mediterranean Extension	3,	½	—	—
Do. Eight per Cent. Preference	10½,	11½	—	—
Reuter's	9½,	10½	10	10
Submarine	234,	39	235¾	235
West India and Panama	1 15-16,	2 1-16	2 3-16	1 13-16
Do. Six per Cent. Preference	7⅞,	8⅛	8 1-16	7 13-16
Western and Brazilian..... x d 15 April	7⅛,	¾	8	7 3-16
West. Union Seven per Ct. 1st Mt.	120,	5	—	—
Do. Six per Ct. Sterg.	102,	4	104	104

TRAFFIC RECEIPTS FOR MARCH, 1880.

COMPANIES.	March 1880.	March 1879.	Incrse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	3,500 estd.	3,256	244	—
Direct Spanish Telegraph Company	—	—	—	—
Direct United States Telegraph Company	—	—	—	—
Eastern Telegraph Company	43,374	41,225	2,149	—
Eastern Extension Telegraph Company	26,425	26,185	240	—
Great Northern Telegraph Company	16,440	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—

ADDRESSES.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

PETER BROTHERHOOD, Engineer, 56 and 53, COMPTON-STREET, GOSWELL-ROAD, E.C.
Specialities—Patent 3-Cylinder Engines (Silver Medal, Paris), as used by Siemens, Gramme, and Wilde for driving Electric Machines.

RANSOMES, SIMS, and HEAD, Orwell Works, IPSWICH.
Specialities—Portable and Stationary Engines, fitted with patent governors, as tried in the electric lighting experiments on the Thames Embankment.

ABBOTT and Co., NEWARK-ON-TRENT.
Specialities—The "Standard Size" Vertical Cross Tube Boilers. Illustrated catalogue, giving every detail of a variety of Boilers, 2s. 6d., post free.

CARBON ELECTRODES COMPANY. Works: 39, COMMERCIAL-ROAD, EAST.
Specialities—Carbon Rods of all sizes for Electric Lighting. Also, Plates and all other Moulded Carbon Goods. List of prices on application.

M. THEILER & SONS, Telegraph Instrument Manufacturers, 86, CANONBURY-ROAD, N. Works: ALWYNE-LANE, N.
Specialities—Morses, Polarised Relays, Saunders' Curb Keys, Type Printers, Recording Sounders, Duplex Apparatus (Theiler's Patent).

HOOPER'S TELEGRAPH and INDIA RUBBER WORKS, MITCHAM and MILLWALL DOCKS.
Contractors for the Manufacture and Laying of Submarine Telegraph and Torpedo Cables. Manufacturers of Hooper's celebrated Insulated Core. Printed reports on application. Offices: 31, LOMBARD STREET, LONDON, E.C.

THE BRITISH ELECTRIC LIGHT COMPANY (Limited), 41, PARLIAMENT-STREET, WESTMINSTER, and 17, WATER-STREET, LIVERPOOL.
Sole Licensees for the well-known Gramme Electric Lighting Machine. Contractors for the supply of Electric Light on all approved systems.

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SLIP

EXTENSION OF FIRE ALARMS IN AMERICA.—Malden, Mass., will extend its fire alarm telegraph to Edgeworth.

QUEBEC.—All the necessary apparatus has been fixed up in the Parliament House, Quebec, for lighting the Council Chamber with the electric light. The trial is to be made immediately.

STILL THEY COME.—The electric light has been introduced into the works of the Fitchburg Steam Engine Company, Fitchburg, Mass., the lighting power being equivalent to 700 gas jets. These works are running day and night.

CINCINNATI.—The Cincinnati and Suburban Telegraph Company, which controls the Bell telephone in that city, has erected a wire to Hamilton, Ohio, and will open communication between the two places for the purpose of transmission of business.

THE SS. POUYER QUERTIER.—A telegram from Penzance on the 27th inst. announced the arrival from Falmouth of this cable steamer, which is laying the Brest section of the French Atlantic cable. It was expected that she would lay the shore end within a few days.

THE DIRECT UNITED STATES CABLE COMPANY (LIMITED).—The board have resolved upon the payment of an interim dividend of 5s. per share, being at the rate of 5 per cent. per annum for the quarter ending 31st March, 1880, such dividend to be payable on and after the 15th May next.

PETROLEUM SHIP STRUCK BY LIGHTNING.—A telegram from Lloyd's agent at Gibraltar states that the Nicolo Tomaseo, an Austrian barque from Philadelphia, bound for Trieste, with a cargo of petroleum, was struck by lightning off Europa Point on April 11, took fire, and was totally destroyed.

MAGNETISING STEEL.—In magnetising steel bars by means of a coil, M. Righi finds that on taking bars of the same steel and the same diameter, and decreasing their length, a certain length is arrived at which no longer yields any magnetisation, whilst smaller lengths give a permanent polarity opposed to that of the coil.

THE UTILISATION OF WATERFALLS.—Mr. J. M. Bois proposes to utilise the force of the Lower Falls of the Genesse River at Rochester, N.Y., for driving machinery for the production of the electric light, and to supply motive force to all the machinery in the city, including the tramcars. He uses compressed air for his purpose.

REGENT-STREET.—The Société General d'Electricité recently made proposals to the St. James Vestry (Westminster), to light Regent-street by the electric light at a cost of $2\frac{1}{2}$ per lamp per hour. The vestry calculated that the total cost of the light would be £18 15s. as against £3 1s. 4d. per annum, the present cost, so the proposal was not accepted.

A NEW CEMENT.—Mr. Sawyer has discovered a cement which he claims will not be affected by change of temperature, and will render his nitrogen-filled globes impermeable. It is quite elastic when cold, and adheres to the glass and metal so closely that it is almost impossible to detach it. It will not melt under 500 degrees Fahrenheit.

A HOUSE STRUCK BY LIGHTNING.—Lightning has greatly damaged Gaer House, occupying the summit of a hill behind Farm House, Wyndcliffe, near Chepstow. The chimneys were thrown down, and nearly every room was damaged. An onlooker, taking shelter under the trees, describes the house as enveloped in blue flame. He was struck down and stunned, but was not seriously hurt.

ELECTRIC CLOCKS FOR PARIS.—On March 22nd M. Fresca brought before the Academy of Sciences a memoir "On the Electric Regulation of the Hour in Paris." A certain number of good clocks are distributed on two telegraphic systems, their action being regulated every second from horary centres. Six of these have been in action since January 3, and six others are about to be set up.

THE TELEPHONE COMPANIES.—Col. Webber, R.E., formerly of the Postal Telegraph Service, is we understand likely to take a prominent position in the management of the Telephone companies working respectively the patents of Bell and Edison. These companies, it is rumoured, will probably effect an amalgamation on the basis of paying a royalty to the Postmaster-General.

IMPROVED TELEGRAPHIC COMMUNICATION WITH FIFE.—The postal telegraph authorities, in order to improve the telegraphic service between Edinburgh and Fife, are placing a new wire between the city and Burntisland, by way of Kirkliston, Queensferry, Inverkeithing, and Aberdour. The work is finished, with the exception of the portion between Aberdour and Inverkeithing, where new poles have to be erected.

QUADRUPLEX IN AUSTRALIA.—Mr. Cracknell, Superintendent of Telegraphs in Sydney, with Mr. McGauran, of Melbourne, has introduced the quadruplex system of telegraphy, by which four messages can be sent on one wire simultaneously. The trials made answer perfectly, and the system will be very shortly introduced into Sydney, effecting a great economy, and reducing the time for a telegram between the two cities to three minutes.

ALDERSGATE-STREET STATION.—It would appear that the electric lighting of the metropolitan Aldersgate-street Station during the last seven months has given satisfaction, since the railway company have determined to adopt it for several other stations as well. The light will be temporarily discontinued in order that the Electric Generator and Light Company, who are supplying it, may make the necessary arrangements for the permanent lighting.

F.R.S.—At the special request of the committee of the Royal Society Professor D. E. Hughes has allowed his name to be enrolled as a candidate for the Fellowship of the Royal Society. The action of the committee in this matter does them great credit, and the election of the electrician who, besides other useful researches, has enriched science with the type-printing telegraph, the microphone, and induction balance, will confer additional lustre on the society.

THE ALBERT MEDAL.—The Council of the Society of Arts are now about to consider the award of this medal for the present year. We notice that, of the seventeen recipients of this tribute to "distinguished merit in promoting Arts Manufactures or Commerce," five are electricians, viz: Professor Faraday, Sir W. Fothergill Cooke and Sir C. Wheatstone (these two names being bracketed together in one award), Dr. C. W. Siemens, and Sir William Thomson.

PRICE GIVEN FOR ELECTRICAL PATENTS.—It is stated that the Union Electric Signal Company of Boston has purchased for 120,000 dollars all the patents of Frank L. Pope, S. C. Hendrickson, and the New York Electric Railway Signal Company; and also the patents of J. B. Odell, E. P. Warner, and the Electric Improvement Company, Galesbury, Ill. The company hopes that the possession of these patents, together with those it already has, will give it the control of railway signalling in the States.

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TELEPHONIC CONCERT.—The telephone was put to a very novel use at Brighton last week, when a military concert was given at the Cavalry Barracks, Preston, situate about a mile from the residence of Colonel Whigham, the commanding officer of the 16th Royal (Queen's) Lancers, the regiment at present stationed there. He had a party at his house in Park-crescent, and to enable them to also listen to the concert, the field telegraph wire used at the review was laid from the barracks to Park-crescent, being suspended from the tops of the trees which line the east side of the Lewes-road, and attached to each end was one of Edison's loud-speaking telephonic instruments. The experiment was very successful, the music being heard with great distinctness.

IS IT OF PRACTICAL USE?—Pierre Valcour, of Lockport, N.Y., has invented a portable cable. A metallic, cigar-shaped vessel, about thirty feet long, contains the machinery and wire. This floats about 100 feet in the wake of the vessel. When 200 miles have been accomplished an automatic connection releases a leaden sinker weighing five pounds, and this as the vessel goes on finds its way to the bed of the ocean. At the point where the sinker is attached the wire is much heavier for a distance of 200 feet. Thus at every 200 miles this shell, which is full of automatic and clock-work machinery, releases a sinker, thus fixing a telegraph wire on the bed of the ocean. The object of the shell is that the wire shall not be at the mercy of the rolling and pitching of the ship.

ELECTRICITY AND SURGERY.—Elephantiosis, which frequently takes the form of an extraordinary enlargement of the foot, leg, or arm, is very frequent in Brazil. It consists in hyperthrophy of the derma and conjoined sub-cutaneous tissues, with infiltration of serum into the meshes of the latter, and is supposed to be due to a disease of the lymphatic system. It is usually treated by compression, but this entails great inconvenience and infirmity on the patient. Two Brazilian physicians, Señors Moncorvo and Da Sylva Aranjo, have conceived the idea of applying electricity to cure it. Señor Moncorvo, who originated the notion, tried induced currents, but only succeeded in reducing the swelling. Señor Aranjo, however, suggested the combined use of continuous and induced currents, which has proved more completely successful. The continuous currents appear to soften the swelling, and, to a certain point, liquify the hardened tissues, while the intermittent currents provoke the re-absorption of the tissues thus prepared by the continuous currents. A number of persons quite disabled by the disease have been cured in this way.

AN ELECTRICIAN IN PARLIAMENT.—Mr. Bernard C. Molloy, just elected as representative for King's County, is a gentleman well known in connection with some of the applications of chemical and electrical science. He was several years ago elected an Associate of the Society of Telegraph Engineers; and in conjunction with Mr. Desmond FitzGerald he took up the question of the production and use as a depolarising agent of solutions of chromic acid in a comparatively concentrated form, and containing but a small proportion, if any, of the potash salt which, in the ordinary "bichromate solution" has so inconvenient a tendency to crystallisation. The "multicarbon battery," intended to be used with these solutions, is probably the most convenient and efficient when currents of great power require to be maintained in action for a considerable period of time. At the meeting of the British Association at Dublin, Mr. Molloy read a most valuable paper on the regeneration of nitric acid from the lower oxides of nitrogen—a subject which at one time at least would have been of special interest to the electrician. He is a strong advocate for the extension of technical education; and, having been called to the bar, may prove a useful ally to those who advocate the retention, extension and improvement of our patent laws.

"SEEING BY TELEGRAPH."—The following letter on this question has been sent by Mr. Middleton, of St. John's College, to *The Times*:—"As I described an instrument for this purpose in a paper read before the Cambridge Philosophical Society on the 8th ult., I beg that you will publish this short account, which professes to give a solution of the problem. Construction of an electrical telescope.—A lens is used to throw on a plane or suitably curved receiving plate (enclosed in a camera) the image of any object. The receiving plate of the camera is composed of thermopile elements, ground to a smooth surface, and having their posterior faces put in electrical communication by a system of wires with a somewhat similarly constructed plate. The heating, &c., effect of the image on the first plate generates currents of electricity, which flow through the wire system, and on reaching the second thermopile plate are reconverted into heat, &c., according to the law discovered by Peltier, the amounts of heat, &c., being directly proportional to the amount of electricity. Moreover, according to the manner in which the elements of the plates are arranged with respect to each other, we can get a 'positive' or 'negative' (to use the ordinary phraseology of photography) picture on the second receiving plate, since the Peltier effect here holds, and the copy of a picture depends solely on establishing a constant ratio in the radiant heat and light which corresponding points of the picture and copy send to the eye. Furthermore, these images can be either viewed directly or by reflected light (after the fashion of the Japanese mirrors and projection on a screen), or by suitable apparatus they can be retained as a photograph, a thermograph, or chemicograph, the details of which will be found in the paper alluded to, and of which an abstract will, I believe, soon appear in the proceedings of the Cambridge Philosophical Society. Also I touched upon the method of attacking the problem of photographing in colours; and, in conclusion, pointed out a striking analogy between the camera of the instrument and that of the human eye; the thermo-electric elements of the instrument and the rods and cones of the eye; the conducting system of insulated wires emanating from the plate of the instrument and the optic nerve (or bundle of conducting fibres of the eye)—supposing that as the electric currents in the instruments effected a registration on the sensitive paper, so in the eye the nerve currents of the optic nerve probably leave some brain trace on the mind."

THERMAL ABSORPTION AND EMISSION OF FLAMES, AND THE TEMPERATURE OF THE ELECTRIC ARC.—An abstract of a paper, by F. Rossetti, on this subject in the *Chem. Soc. Journal*, says:—Flame is very diathermous, and consequently its absorbing power for heat rays is small. If the radiation from a flame (luminous or non-luminous) traverses another of the same nature, having a thickness of 0·01 m., the co-efficients of absorption and transparence are respectively 0·135 and 0·865. The transparence and absorptive power decreases and increases respectively, in proportion to the thickness of the flame. An infinitely thick flame is athermous, and its absorptive power unity. This limit is nearly reached with flames of finite thickness, for a flame 1 m. in thickness is almost completely athermous to rays from a flame of the same nature. The formula $y = a\frac{1 - k^{\epsilon}}{-\log. k'}$, represents the intensity of radiation of a flame, having a

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given thickness ϵ, expressed in centimeters. The coefficient of transparence $k = 0{\cdot}865$; a = a constant, the value of which depends on the nature of the flame. The intensity of radiation of a luminous white flame of infinite thickness, compared with the intensity of radiation of lamp-black at the same temperature, is equal to unity. This is the absolute power of emission. The absolute power of emission of the non-luminous pale blue flame of the Bunsen burner is equal to 0·3129. The relative power of emission of a flame is thus determined, multiplying the ratio between its intensity of radiation and the *maximum intensity* (the intensity of radiation if the same flame were of an infinite thickness), by the absolute power of emission of the class of flame to which the one in question belongs. The electric light emits two classes of rays, one from the incandescent carbon, which are white, the other from the voltaic arc, which are bluish purple; these together give a bluish-white light. The temperatures of the two carbon poles differ, and they may be calculated from the formula $y = m\,T^2\,(T - \theta) - n\,(T - \theta)$, on the supposition that the emission power of the carbon is a maximum. The power of emission of the voltaic arc is very small, like that of non luminous flames. Its temperature may be calculated from the above formula, but it is necessary to introduce the value of the emission power of the arc proportional to its thickness. Experiments show that the maximum temperature of the incandescent portion of the positive pole is about 3,900°C., and that of the negative, 3,150°C. The temperature of the voltaic arc between the poles is always the same, about 4,800°C., whatever the volume of the arc or the intensity of the current.

Franklin Institute.—The following appears in the minutes of the Franklin Institute for March 17th, 1880 :—"The secretary read the report of Prof. Henry Morton on the Tests made of the Electric Light at the Coney Island Pier in September last. It was stated, in explanation of the purpose of this examination, that the Brush Company had agreed to give a light of 2,000 candle-power, each with 22 horse-power, the small machine to run 900 revolutions per minute, the large one 750 revolutions per minute. They exceeded this speed four per cent. The twelve-inch carbons used cost fifteen cents each, and the consumption was two inches per hour each. Mr. McKean inquired what equivalent light in gas jets per horse-power was furnished, saying that so many 'candles' was not as clear an expression as to volume of light as so many gas jets, with the power of which we are familiar. At the request of the president, Prof. Rogers explained the manner of testing lights by comparison with standard candles, and mentioned a new means of testing lights for their colour by establishing a standard of incandescent platinum heated by a battery of known power. Mr. McKean expressed his thanks for the information as to candle power, but again repeated his question. The president stated that it was only a matter of calculation. The average power of the lights was said to be 500 candles. There were 16 lights, giving an aggregate of 80,000 candles, by the expenditure of 21½ horse-power, or nearly 400 candles per horse-power. From this the number of gas jets of given candle power could be calculated. He called attention to the fact that, while the large machine mentioned in Prof. Morton's letter required 1·35 horse-power per light, the smaller machine, running six lights for 4·3 horse-power, required only about ·71 horse-power per light. Prof. Marks said that at Wannamaker's depôt there were 50 lights maintained by 65 horse-power, more than a horse-power for each light, and almost exactly the same as the results shown by the larger machine mentioned in Prof. Morton's letter. He said that at Edison's the light of only about 25 or 30 candles, he believed, was obtained per horse-power. Prof. Rogers said that there was no doubt of the fact that the economy of power was enormously greater in the voltaic arc system than in the incandescent system of electric lighting. His estimate of the amount of light furnished at Edison's laboratory was a little higher than that of Prof. Marks—about 40 candles per horse-power—while that of the lamps mentioned in Prof. Morton's letter was 400 candles per horse-power, a difference of ten to one in favour of the voltaic arc. Economy cannot be obtained by the incandescent method."

Enlightenment.—On April 16 Mr. J. Northam, Superintendent of Postal Telegraphs in Sheffield, delivered a lecture in the Temperance Hall, Townhead-street, on the "Electric Telegraph." Mr. J. Robertshaw presided, and there was a good attendance. The lecture was delivered in support of the funds of the Sheffield Friendly Society's Medical Aid Institution. Mr. Northam stated that there were two objects of the greatest importance to this country, "The Electric Telegraph," and the "Free Press" of Great Britain. The telegraph had completely changed the status of the Press, and had raised it to the highest perfection. Speeches delivered in Russia, Turkey, or an address at Dundee or Plymouth at night would be on the morrow found word for word in the Sheffield papers. The lecturer said that electricity travelled through a copper wire 186,000 miles in a second; through an iron wire 15,400. He next explained the system by which three messages can be sent in contrary directions on the same wire at the same time. He passed on to say that no instrument had excited more interest and wonder than the telephones of Professor Bell. No less than 40,000 telephones were in daily use at an annual rental in America. The shares of the Telephone Company there were quoted at 200 premium. The public had apparently formed an erroneous judgment of the capabilities of the telephone from having heard instruments of an inferior manufacture. In Sheffield scores of the instruments had been fixed in the town and neighbourhood, and yet, to the lecturer's astonishment, some of the members of the Sheffield Town Council said in their places on Wednesday that the telephone was "newfangled," "experimental," and otherwise unfit for practical purposes. These gentlemen not being content to simply negative the proposition which was before them, namely, to connect the municipal offices by telephone, deliberately went out of their way to damage the invention the merits of which they were evidently unacquainted with. The lecturer strongly recommended these gentlemen to try the telephone for themselves before attempting to join such a discussion in future. The fact of the telephone being able to transmit actual speech to any distance with "ease," "certainty," and "secresy" was too patent in its advantages to need any recommendation. The application of electricity for domestic purposes was also fully explained, and it was shown how bells could be fixed in connection with the sashes of the windows of a house, or with the doors, so that the presence of thieves or intruders would at once be signalled all over the house if they attempted to enter the premises. Apparatus was fastened to a door in the room which, connected with an alarm bell, rang when the door opened, and continued to ring until it was re-closed. Several amusing telegrams which had been sent over the wires were quoted, and caused much merriment. At the conclusion of the address several experiments were given. Communication was made with London, and through it with all parts of the United Kingdom. Hearty votes of thanks were accorded to the lecturer and chairman.

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RESEARCHES ON THE CONDITIONS WHICH INFLUENCE THE FORCE OF ELECTRO-MAGNETS.

BY M. DU MONCEL.

[Abstract of the Author's Paper in *La Lumière Electrique.*]

(CONCLUDED FROM P. 269.)

IV.—CONDITIONS OF FORCE IN ELECTRO-MAGNETS RELATIVE TO THE CURRENT AND TO THE MAGNETISING COILS.

The author observes that the laws of electro-magnetism, and those relative to the current, are both involved in the considerations which come under this heading, and that the latter are accurately summed up in the formulæ of Ohm. The laws relating to electro-magnets are less precise; nevertheless, in accordance with the researches of Jacobi, Dub, Muller, and others, it is admitted that, with a given intensity of current, the electro-magnetic force is proportionate to the number of turns of wire in the magnetising helix, to the diameters of the magnetic cores, and to the square roots of their lengths; whence it follows that, when the current is variable, the electro-magnetic force is proportionate to these various elements multiplied into the intensity of current.* Moreover, if, instead of magnetic force or magnetic *moment*, we consider the attractive force which is the result of action and reaction between the armature and the electro-magnet, we arrive at the conclusion that the electro-magnetic attractive forces are proportionate to the different factors which have been mentioned raised to the second power.

If then we call F the magnetic moment, A the attractive force, I the intensity of the current, t the number of turns in the magnetising helix, c the diameter of the magnetic core, and b its length, we have:—

$$F = I\,t\,\sqrt{c}\,\sqrt[4]{b} \text{ and } A = I^2\,t^2\,c\,\sqrt{b}.$$

And, if we substitute for I in these two equations its value according to the formulæ of Ohm, taking into account all the material elements entering into the construction of an electro-magnet, we arrive at two mathematical expressions which, treated by the calculus, lead to conditions of *maxima* of some interest, and capable of furnishing very valuable indications for the construction of electro-magnets. These have been referred to at length in the three memoirs entitled:—*Researches on the best conditions for the construction of electro-magnets. Determination of the elements of construction for electro-magnets. Researches on electro-magnetic maxima.* The author explains briefly as follows the mode in which questions relating to "electro-magnetic work" admit of conditions of maximum.

Since the electro-magnetic force is proportionate to the number of turns of wire in the magnetising helix and to the intensity of the current which excites it, and since, on the other hand, the number of turns of wire cannot be augmented without increasing the resistance of the circuit and consequently diminishing the intensity of the current, there must be a limit at which any gain of force by increasing the number of turns of wire is counterbalanced by what is lost through the increase in the resistance of the circuit, and it is precisely this limit which cannot be passed without losing force. Now, the limit in question is indicated by the calculus, and it varies according to the conditions of the experiment. Again, it will be understood that, if force be gained by augmenting the diameter of the magnetic core, force is also lost by reason of the increased diameter of the turns of wire, through which the resistance of the circuit is increased, if the number of turns be constant. So that here again there are conditions of maximum which are indicated by the calculus; and the same applies to the case where the length is varied. Now, if the question be considered generally, the following conclusions will be arrived at:—

1. If we take a number of electro-magnetic coils of the same length, wound with the same description of wire but with a different number of layers, that one will give the best result, in an external circuit of given resistance, *of which the resistance is to the resistance of the external circuit as the thickness of its helix,* plus *the diameter of the magnetic core is to the simple thickness of the helix.*

2. If we take several electro-magnetic coils of the same length, and with the same thickness of helix, but wound with wires of different diameters, the one which will give the best results on a circuit of given resistance is that of *which the resistance is equal to that of the external circuit,* at least if the thickness of the insulating envelope be neglected.

3. If, in the preceding case, the thickness of the insulating envelope be taken into account, the coil to be selected is that *of which the resistance is to the resistance of the external circuit as the diameter of the uncovered wire is to the diameter of the same wire when coated with its insulating envelope.*

4. In the preceding deductions the external resistance of the circuit should be considered as representing that of the conducting wire plus that of the battery, if the circuit be *simple* and insulated, and as representing the *total* resistance of the circuit *taken inversely, if the circuit has derivations or is badly insulated.*

5. With a sufficient electrical intensity, it is advantageous to wind electro-magnets, so that *the thickness of the layers of wire may be equal to the diameter of the iron cores;* but in this case the diameter of the cores should be proportioned to the electrical intensity which is to act upon them, and the cores should be selected so that this intensity may magnetise them nearly to the point of saturation.

6. The total length of the magnetic core between the two poles should theoretically be eleven times its diameter, or, practically, twelve times.

From these different laws, and from the formulæ leading up to them, may be deduced the following laws, which are of extreme importance in electrical applications:—

1. For circuits of equal resistance, the diameters of electro-magnets established under the conditions of a maximum should be proportional to the electromotive forces brought into action.

2. For equal electromotive forces, these diameters should be inversely as the square root of the resistance of the circuit, including that of the battery.

3. For equal diameters, the electromotive forces should be proportionate to the square roots of the resistances of the circuits.

4. With a given electromotive force and with electro-magnets placed in their condition of maximum, the electromotive forces of the batteries to excite them should be proportionate to the square roots of the resistances of the circuit.

These different laws are true only in the case of electro-magnets which can obtain magnetic saturation; when they cannot do so, whether in consequence of their too great size, or by reason of the shortness of the time during which they are acted upon by the current, then *the helices should always have less resistance than the external circuit, and the shorter the time the current acts the greater should be this difference.*

Amongst the various deductions above set forth, the one which is the first in order differs somewhat from the generally accepted law, and has formed the subject of a discussion between M. du Moncel and Messrs. Heaviside, Brough and Raynaud. In his present paper, M. du Moncel observes that, in answer to the memoirs arising out of this discussion, he showed clearly that the generally admitted law formulated under No. 2 was the only one that could be arrived at from the *incomplete formulæ* which had up to that period been discussed, and that the other conditions of maximum formulated by him follow from those formulæ which take into account all the elements entering into the construction of an electro-magnet. It is true that when we start with a given diameter of the iron core, and when, in consequence of other conditions of maximum, the thickness of the layers of wire should be equal to the diameter of the magnetic cores, the generally admitted conditions of maxima are those which should be taken into consideration. But when an experimenter wishes to know the resistance of the circuit on which he may most usefully employ a given galvanometer or electro-magnet, the conditions of maxima set forth in the first instance are those which have to be regarded, and these conditions indicate that this resistance of the external circuit should be less by half than that of the electro-magnet, if the thickness of its magnetising helix is equal to the diameter of the core, as should be the case.

In the different memoirs which have been mentioned above, the author has shown how it is possible to determine the numerical values of the different elements of construction in an electro-magnet. Without entering into the numerous calculations leading to the simple formulæ given, he indicates as follows the mode in which it is necessary to proceed.

In the first place, in order to calculate the dimensions of an electro-magnet in its conditions of maximum, relatively to a given electromotive force E and a given external resistance R, we must commence by calculating its diameter c by means of the formula $c = \frac{E}{\sqrt{R}} \cdot 173$. Now the total length of the magnetic core should be $12c$, and the diameter g of the wire coated with its insulating envelope is given by the formula:—

$$g = \sqrt{f\sqrt{\frac{c^3}{R}} \cdot 00020106}.$$

To obtain the diameter of the uncovered wire this value must be divided by f, that is to say by the number 1·4 or 1·6, according as the wire is of moderate thickness or very fine.

* We question whether, if the term "force" be taken in its accurate dynamical acceptation, this last factor should not here, as in the subsequent case, be the *square* of the intensity of current. "Intensity" of current varies as (and simply signifies) *current.*—ED. *E.*

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The number of turns of wire in the helix is given by the formula $\frac{12\,c^2}{g^2}$, and the length of wire in it by the formula,

$$\frac{75{\cdot}4\,c^2}{g^2}.$$

To calculate the attractive force in grammes when the distance of attraction is 1 millimetre, the formula is

$$P = \frac{I^2\,t^2\,c^{\frac{3}{2}}}{{\cdot}0000855},$$

in which formula the value of I is $\frac{E}{2\,R}$.

The author concludes by stating that the dimensions to be given to an electro-magnet, and the battery power to be employed in order to obtain a given force on a circuit of given resistance, may be calculated by means of the simple formulæ given by him in the memoirs in question.

ON THE DISRUPTIVE DISCHARGE OF ELECTRICITY.

BY ALEX. MACFARLANE, D.SC., AND P. M. PLAYFAIR, M.A.

During the months of November and December of this Session we have investigated certain questions suggested by the results already communicated to the Society.

Difference of Potential required to pass a spark between (1) *two equal spherical balls at different distances*, (2) *a plate and ball at different distances, and* (3) *a plate and point at different distances.*

A series of observations was taken for each of these, and on three successive days, without altering the arrangement of the apparatus or the charge of the electrometer. The couple of small Leyden jars were attached to the conductors of the Holtz machine, as we had previously found that it was impossible to observe the discharge between a plate and point with any degree of accuracy when the capacity was small.

Two balls, each of $\frac{2}{3}$ inch diameter.—The series of observations for the two balls is a more minute and extended investigation of a problem we took up and solved approximately before. We have observed more minutely the values of the readings at the smaller distances, and also noted the cause of the irregularity at the ends. We found that at 80 mm. small violet sparks began to pass before the principal white spark, and that the reading was then more ambiguous than for smaller distances. Escape from the conductor was first noticed at 120 mm.*

Plate and Ball.—We employed a tin plate 8 inches diameter, and one of the brass balls used in the previous experiment. The curve obtained is not very different from that for the two balls; it is somewhat more circular. Small sparks passing before the large one were observed to begin at a shorter distance than in the previous case. Another irregularity at the end was due to the passing of two large sparks. Finally, the electricity began to escape from the insulated wires.

Plate and Point.—The plate used was the tin plate of the previous experiment; the point was conical and of brass. From 1 to 5 mm. the discharge was in the form of a white spark; for higher distances nothing was visible excepting a glow at the point. The series was continued up to 200 mm., as there was no difficulty due to escape of the electricity into the air.

Discharge through a Solid Dielectric.—We obtained, by favour of Mr. Calderwood, of Addiewell Chemical Works, a quantity of a pure solid paraffin of low melting point. The plate electrodes were separated to a distance of $\frac{1}{3}$ inch inside a glass vessel, the liquefied paraffin poured in so as to cover the plates completely, and then allowed to solidify for twenty-four hours. When the plate electrodes were charged the first spark which passed was large, and illuminated the whole of the paraffin, but the succeeding discharges were much smaller, and of equal amount. The first spark produced a deflection 3·6 times as great as the succeeding sparks. When the plate of paraffin was examined afterwards it was found to be perforated in a zigzag manner, the hole being surrounded by char. We found that—

Electric Strengths.

Air	1
Paraffin when solid	5
Paraffin when liquid	2·5

Thus the electric strength of this substance when in the solid state is, to its electric strength when in the liquid state, as 2 to 1.

As an instance of how these experiments may be made directly useful, I may mention that we obtained two samples of liquid paraffin from Mr. Calderwood to compare their electric strength. We found the ratio to be 1·6. It is, however, extremely difficult to effect the comparison unless we have a considerable quantity of each specimen. It is best to have a dish of the above form, where we can have broad plates, the lower one slightly raised above the glass bottom, and the upper one well immersed in the liquid. The former of these conditions helps to prevent solid particles getting in between the plates, and the latter prevents the rising of the liquid up the stem, and consequent splashing about of liquid particles.

Discharge through Paraffin Vapour.—We put the discharging vessel, with a quantity of one of the pure liquid paraffins, inside the receiver of an air-pump, exhausted the air, and allowed the paraffin vapour to accumulate. When the barometer-gauge indicated 50 mm. pressure, the distance being $\frac{1}{3}$ inch, we took sparks through the vapour. The spark was of a broad section, green at either end, but of a deep violet between. When a quantity of air was let in white jagged sparks were observed in the midst of the coloured spark. From the readings obtained at 50 mm. pressure we infer that this paraffin vapour is 1·7 times as strong as air.—*Proceedings Royal Society of Edinburgh.*

* Hence the irregularity previously observed is not due to the escape of electricity into the air, but to the passage of small sparks between the electrodes.

EFFECTS OF ELECTRIC CURRENTS ON THE SURFACES OF MUTUAL CONTACT OF AQUEOUS SOLUTIONS.*

BY G. GORE, LL.D., F.R.S.

In the year 1859 I made the following experiments, for the purpose of ascertaining whether visible movements, similar to those obtained by passing an electric current through mercury and an aqueous solution, could be obtained by passing a current through the surface of mutual contact of two aqueous liquids alone:—

"1st. A definite layer of oil of vitriol was placed beneath a layer of distilled water weakly acidulated with sulphuric acid, and the terminal wires of a voltaic battery immersed in the upper liquid; no visible movements occurred at the boundary line of the two liquids.

"A dense solution of cyanide of potassium was placed in a small glass beaker, a few particles of charcoal sifted upon its surface, and a layer of aqueous ammonia, half an inch deep, carefully poured upon it. A vertical diaphragm of thin sheet gutta percha was then fixed so as completely to divide the upper liquid into two equal parts; the vessel was placed in a strong light, and two horizontal platinum wire electrodes, from sixty-six freshly charged Smee's cells, were immersed one-eighth of an inch deep in the liquid ammonia on each side of the diaphragm. A copious current of electricity circulated, but no movement of the liquids at their mutual boundary line could be detected." (See *Proc. Roy. Soc.*, vol. x, 1860, p. 235, par. 9).

Recently, also, I have made similar experiments, but in a much more searching manner, in order to ascertain whether an electric current, passing between two aqueous liquids, affects their diffusion into each other. The essential difference in the form of these experiments from that of the above-mentioned ones was to concentrate the action of the current upon a very much smaller surface of contact of the liquids, and thus render any visible effect upon their diffusion more manifest.

After making several forms of apparatus, in order to obviate certain difficulties of manipulation which arose and were fatal to success, I found that, when an electric current was passed between the surfaces of mutual contact of certain aqueous solutions of different specific gravities, the boundary line of contact of the two liquids became indefinite at the surface where the current passed from the lighter into the heavier solution, and became sharply defined where the current left the heavier liquid and re-entered the lighter one; and that on reversing the direction of the current several times in succession after suitable intervals of time, these effects were reversed with each such change. Also, in various cases in which the contiguous boundary layers of the two liquids had become mixed, the line of separation of the two solutions became, by the influence of the electric current, as perfect as that between strata of oil and water lying upon each other. In rarer cases two such distinct lines of stratification appeared. Other new phenomena were also observed.

As I have sought, without success, for any record of previous discovery of essentially similar effects, and as it is evident that those I have observed belong to a large class of similar phenomena, I beg leave to take the earliest opportunity of submitting this brief statement to the Royal Society.

* Abstract of a Paper presented to the Royal Society,

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THE ELECTRICIAN.

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ROOM FOR WORK.

Faraday, writing in 1832, said, "I have in a recent series of these researches proved (to my own satisfaction at least) the identity of electricities derived from different sources, and have especially dwelt upon the proofs of the sameness of those obtained by the use of the common electrical machine and the voltaic battery.

"The great distinction of the electricities obtained from these two sources is the very high tension to which the small quantity obtained by aid of the machine may be raised, and the enormous quantity in which that of comparatively low tension, supplied by the voltaic battery may be procured; but as their actions, whether magnetical, chemical, or of any other nature, are essentially the same, it appeared evident that we might reason from the former as to the manner of action of the latter; and it was to me a probable consequence that the use of electricity of such intensity as that afforded by the machine, would, when applied, effect and elucidate electro-chemical decomposition, show some new conditions of that action, evolve new views of the internal arrangements and changes of the substances under decomposition, and perhaps give efficient powers over matters as yet undecomposed."

The reasoning of Faraday holds good to-day. The introduction and improvement of dynamo and magneto-electric machines has placed a power in the hands of experimenters of which Faraday knew little or nothing at the time the above was written. A systematic use of these machines in electro-chemical work has yet to be made, and we have no hesitation in saying that the probability of valuable results approaches almost to certainty. It is true that certain desultory investigations have been made, but as yet we have heard of no chemist or physicist who has systematically studied the electro-chemical action of these machines. It has long seemed to us that the great field open to young students is that of electro-chemistry. Davy worked at the beginning of the century, Faraday in the middle, to be followed by whom at the end? The admirable sytem adopted by the Chemical Society of abstracting all important papers on chemical subjects shows the gradual tendency of chemical experts to introduce electricity into their investigations. In the April number students would do well to study the work of M. C. Luckow in applying the electric-current to analytical chemistry. The author considers the qualitative behaviour of various soluble and insoluble compounds of the commoner elements under the influence of the current, and the electrolytic quantitative separation and estimation of various metals, partly in the metallic state, and partly in the state of compounds of constant composition. In the experiments a constant battery, or a thermo-electric pile was used. Preference is given by the author to Meidinger's form of battery and to Clamond's pile. Much of what M. Luckow states in his paper is well known, but in this compendious form it may well serve as a base from whence the student can work. Although we do not as a rule recommend the production of text books, there is a void in scientific literature which we wish to see filled. In such works as "Watt's Dictionary of Chemistry," and especially in the transactions of learned societies, there exists information which would be valuable if carefully edited and adapted to student wants. To return, however, to M. Luckow. He points out that the action is different according to the circumstances under which the current acts. The galvanic current in acid solutions has mainly a reducing, and in alkaline solutions an oxidising action. In the electrolysis of cyanides the cyanogen undergoes further decomposition, the final products being carbonic anhydride and nitrogen. He refers to solutions of chlorides, iodides, and bromides. His experience with nitric acid is that it decomposes with the production of nitrous acid, but with feeble currents and acid of sp. gr. 1.2 this decomposition does not occur. No ammonia is produced from dilute nitric acid, either *per se* or in presence of sulphuric acid; but if a solution of cupric sulphate is added in sufficient quantity ammonium sulphate and metallic copper are produced simultaneously until all the nitric acid is converted into ammonium sulphate. The metals of the sixth group are separated from their solutions in the metallic form. If arsenic, antimony, and tin occur in the same solution the metals are precipitated in the above order. It is not the place here to continue this list, but we have sufficiently indicated the advance made since 1807, when Davy, in his paper "On Some Chemical Agencies of Electricity," showed for the first time that the acid and alkali developed by galvanic agency were derived from the decomposition of a salt, that the metals potassium and sodium were to be obtained from the decomposition of potash and soda. It was Davy, again, who separated metals from lime, baryta, strontia, and lithia; but he failed with the non-alkaline earths such as alumina, glucina, yttria, and zirconia, which have since, however, yielded to other modes of decomposition. Davy's last paper in 1819 was on "The Electricity of the Torpedo."

A fruitful source of experimenting has been the attempt to obtain metals from their ores by means of the electric current, but hitherto all successful methods have proved too costly to be practically used. It is, perhaps, to such experiments, and to the cheap production of many chemicals of every day consumption that attention should be directed. There are still residues and bye products arising in our manufacturing industries requiring treatment, with which electricity may be

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able to deal even should it not be applicable to the main industry itself. We, therefore, again recommend some of the young students in whose eyes the whole field of scientific research is fully occupied to turn their attention to electro-chemistry, with the full assurance that perseverance will bring a rich reward. Chapman's lines, slightly modified, will then become the writer's theme,

Of all men's wits alive,
I most admire Valerius', that hath stolen
By his mere industry, and not by spurts,
Such qualities as no wit else can match
With plodding at perfection every hour.

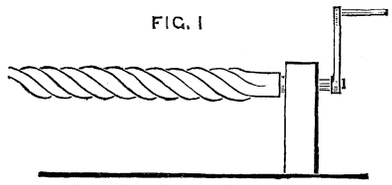
ON THE SPECIFICATION OF THE DIRECTION OF THE LAY OF THE OUTER WIRES OF A TELEGRAPH CABLE.

BY F. C. WEBB.

The wires forming the outer sheathing of a submarine cable can, of course, only be laid on in two different directions, and, therefore, it would appear at first sight that very little misunderstanding could occur on the subject, yet, through a misunderstanding, half the first Atlantic Cable of 1857 was made with a lay reverse to the other half, thereby rendering it necessary to take certain precautions to prevent the cable untwisting at the central splice.

One lay is called "right hand" lay, and the other "left hand" lay, but on what authority, or why one should be termed "right" and the other "left" the author has not been able to trace in any published record, although he has searched in most of the encyclopædias and books of reference in which rope making is mentioned. He has heard two different reasons given:—The one that the "right hand" lay is that made by a man turning a simple rope-laying machine with his right hand; in which case, as he we would stand with the rope on his right-hand side, and as a man generally turns a handle, pushing when the handle is at its greatest height, he would produce a rope as shown in Fig. 1.

FIG. 1



Another reason given has been that this lay corresponds with the direction of what is called a right-hand screw. The reverse lay is, on the same principle, called a left hand lay.

It has been stated to the author, however, that everybody is not agreed even on this nomenclature, and if this is the case it is time that some attention should be drawn to the matter, for cables have been largely made to both lays, one manufacturer making in one direction, others in another, whilst some have made both lays. Even quite recently the author saw in the specimen case of a manufacturer the shore end and deep sea portion of two different cables in which the lay of the shore ends was reverse to the deep sea. It will be easily imagined that in sending from abroad for cable for repairs it is essential to specify the direction of the lay, as otherwise it is quite possible that spare cable may be ordered from some manufacturer who did not make the cable to be repaired, and who makes with a reverse lay to that of the manufacturer who made the cable for which the spare cable is required for repairing.

Indeed, no specification of a cable can be considered complete unless the lay of the wires is specified, not only for the immediate purpose of the specification but as a record, and to make sure that there shall be no misunderstanding it is better to sketch the lay on paper.

Yet no specification the author has seen contains this except some of his own.

In 1854 three cables were ordered for the Electric Telegraph Company for the Irish Channel, between Holyhead and Howth, and from the author's experience on the Hague cables repairs he had found that it would be of great advantage to be able to identify the cables at sea when brought to the surface, as when cables are placed very near one another the position of the ship is not sufficient to identify them. Two of the Irish cables were, therefore, specified to be made of opposite lay, and the third to have a worming of an extra wire, and in an old letter copying book he finds the specification for the shore ends, which were made by Messrs. Glass and Elliot. It is dated Oct. 18, 1854. In this he had taken the precaution of specifying and drawing the lays thus:—

The cables to be of the following lengths and lay:—

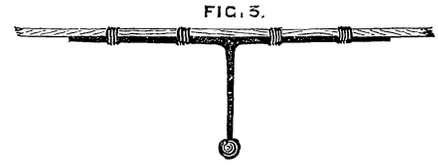
1. One mile of left hand lay.
2. Three miles of ditto.
3. One mile of right hand lay.
4. Three miles of ditto.
5. One mile of left hand lay, with a No. 12 galvanised iron wire wound round outside.

FIG. 2

Twelve miles of the left hand lay cable made for Ireland were afterwards used in June, 1857, to renew a portion of one of the Hague cables, which were right hand lay, and it was necessary to take precautions to prevent the cable untwisting at the splices.

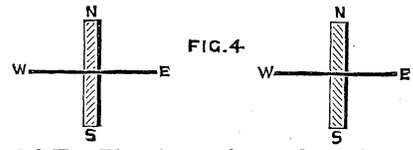
At each splice the following plan was therefore adopted by the author. An iron plate, tapered from the middle each way, and grooved in its whole length to the radius of the cable, something like the fish piece to a boat's yard, but with an iron arm projecting from its centre, carrying a weight, as shown in Fig.

FIG. 3.



3, was firmly lashed to each of the two splices. Thus any tendency to untwist was counteracted by the weight. The same plan was adopted in the central splice of the Atlantic cable of 1858. The adoption of two different lays for the Irish cables, causing pieces of cable of different lay to be kept in stock at the Electric Telegraph Company's Stores at Lowestoft, required that care should be taken to issue the proper cable for any particular repair. The term *right hand* and *left hand* was at first employed, but led to mistakes, and indeed it has in itself nothing to guide a person as to what it means without he previously knows and recollects the meaning any more than A and B, 1 and 2, or + and —. The author then adopted the following phraseology:—Let a piece of cable be placed with its axis vertically, and let it be supposed that its axis is a north and south line, then the direction of the wires seen will either run in a direction approaching north-east and south-west, or the reverse direction; that is to

FIG. 4



say, N.W. and S.E. Thus in one figure above the lay is N.W. and S.E., and in the other it is N.E. and S.W. Thus we have only to hold a piece of cable vertically to see whether it is a N.W. lay or N.E. lay. And in using this mode of specifying the lay all we have to recollect is that the axis of the cable is the N. and S. line, and the names become N.E. for right-hand lay and N.W. for left-hand lay. But whether this plan of specifying, or the unmeaning one of right hand and left hand be adopted, it is certain that some care should be taken to specify the direction of the lay of every cable. Of course, when a whole new cable for some new locality is ordered from a manufacturer it is not of so much importance for the moment what lay it is, but it is of importance to insert the lay in the specification for future reference, so as to know what to order for repairs. Most certainly, at any rate, when cable is ordered for repairs, the direction of the lay should be specified. Only recently an order came from New Zealand for open tender for a length of three-conductor cable for repairs. The papers of the last order had to be searched up to find who made the cable, and then the manufacturer had to be visited and asked as to the lay, when he said the lay must have been such and such a lay, although there were cables of different lays in his case. Indeed, it seems more by luck than anything else if some mistakes have not already occurred. The following are a few of the particulars of lays:—

Right hand, or in the proposed phraseology, N.E. lay:

1. Most of Messrs. Newall and Co.'s cables.
2. The Direct United States deep sea cable—Atlantic cable.

Left hand, or in the proposed phraseology, N.W. lay:

1. Most of Messrs. Glass and Elliot and Telegraph Construction Company's cables, including the 1865, 1866, 1869, 1873, and 1874 Atlantic cables.
2. The India Rubber, Gutta Percha, and Telegraph Works Company's cables.

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CORRESPONDENCE.

THE NOMENCLATURE OF THE ELECTRICAL UNITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to the article under this heading in your last issue, it may be of interest to reproduce the following letter (which, with other communications on this subject, appears to have been lost sight of), from a distinguished member of the Committee on electrical units, which was printed nearly ten years ago in the *Electric Telegraph and Railway Review*. The table given by Mr. Varley was subsequently corrected, probably by his authority; the veber being taken as the unit of quantity, and the farad for the unit of capacity. I enclose also an extract from a letter signed "X.X.X.," and published in the *Engineer* in October, 1870, which contains the correction referred to. I do not know who "X.X.X." may have been, but he wrote with evident knowledge of his subject. I apprehend that the only correction to be made in the table furnished by "X.X.X." is in the spelling of the name given to the unit of quantity. The spelling should be *weber*, the pronunciation *veber*. I would strongly deprecate the adoption of any distinctive name for the unit of current, which is and should be expressed as *unit quantity in unit time*. In conclusion I would refer your readers who are interested in this subject to a letter of mine published in your issue of October 5th, 1878.—I am, &c.,

DESMOND G. FITZGERALD.

B. A. UNITS.

(To the Editor of the *Electric Telegraph and Railway Review*.)

"SIR: The name for the unit of capacity has been under discussion during the last year by many members of the unit committee, some writers using the word "farad" to express that capacity which others term a microfarad. At the instance of Messrs. Latimer Clark, Fleeming Jenkin, Sir William Thomson, Mr. Hockin and myself, it has been decided to adhere to the original principle, of naming these units, and it will doubtless be a service to electricians to know what are the capacity values of the names adopted.

At the suggestion of Mr. Latimer Clark, the names of the great electricians were selected for naming these B.A. units, which are multiples, of convenient magnitude for telegraph engineers of the "metre second" units. The unit of resistance is the "ohm," the unit "potential" or "intensity" is the "volt," the unit of capacity is the "farad" and the unit of quantity the "veber."

The prefixes "mega" and "micro" signify respectively one million and one millionth.

The following table illustrates the value of the adopted units:—

	Unit's Names.	Value of the unit in EM units.	1,000,000 units, and value in EM units.	$\frac{1}{1000000}$ units, and value in EM units.
Resistance...	Ohm	10^{7}	Megohm $= 10^{13}$	
Capacity.....	Farad....	10^{-7}	,,	Microfarad $= 10^{-13}$
Potential.....	Volt.....	10^{5}	,,	,,
Current	Veber ...	10^{-2}	,,	Microveber $= 10^{-8}$

$$\text{Veber} = \frac{\text{Volt}}{\text{Ohm}} = \frac{10^{5}}{10^{7}} = 10^{-2},$$

$$\text{Microveber} = \frac{\text{Volt}}{\text{Megohm}} = \frac{10^{5}}{10^{13}} = 10^{-8},$$

$$\text{Farad} = \frac{\text{Veber}}{\text{Volt}} = \frac{10^{-2}}{10^{5}} = 10^{-7},$$

$$\text{Microfarad} = \frac{\text{Microveber}}{\text{Volt}} = \frac{10^{-8}}{10^{5}} = 10^{-13}.$$

Those most in use are the "ohm" for measuring the "resistance" of the conductor, and the "megohm" for measuring the "resistance" of the gutta percha. The microfarad, frequently called heretofore by *mistake* "a farad," is the unit of "electrostatic capacity," and, for the purpose of giving a rough idea, it may be remarked that modern submarine telegraph cables have a copper resistance averaging between three and twelve "ohms" per naut, and that they have an electrostatic capacity averaging between $\frac{2}{10}$ and $\frac{4}{10}$ of a microfarad per naut. The volt is something less than a Daniell cell, the latter being about 8 per cent. greater than the volt.

Sir William Thomson defines the "farad" "as a condenser whose capacity is such that the quantity of electricity, which, driven by a volt during a second of time through the resistance of an ohm, charges it to a potential equal to that of a volt;" in other words, it is a condenser of such capacity that a current of one veber during one second will charge it to one volt potential.

I would, in conclusion, remark that the word "farad" has been used in connection with submarine cables; it should be read "microfarad."—Your obedient servant,

CROMWELL F. VARLEY.

London, 22nd Sept., 1870."

BRITISH ASSOCIATION UNITS OF ELECTRICAL MEASUREMENT.

(To the Editor of the *Engineer*.)

"SIR: The magnitude of the B.A. unit of resistance (called an ohm) was chosen at 10^{7} absolute-resistance units because its value differs only about 5 per cent. from that of Siemens, which has for years past been found to be a convenient measure.

The magnitude of the B.A. unit of electromotive force (called a volt) was chosen as 10^{5} absolute units of electromotive force because it was within 8 per cent. of the value of a Daniell element, and was about a mean value of all galvanic elements, and, therefore, a convenient unit.

With these two multiples given, the remainder are necessarily only deduced values; thus as the current in any circuit is equal to the quotient $\left(\frac{\text{electromotive force}}{\text{resistance}}\right)$, it would follow that the B.A. unit of current can be no other than $\frac{\text{volt}}{\text{ohm}} = \frac{10^{5}}{10^{7}} = 10^{-2}$ absolute units of current.

Therefore, the B.A. unit of capacity is $\frac{10^{-2}}{10^{5}} = 10^{-7}$ absolute units of capacity, as stated by Mr. Varley.

In Mr. Varley's table he has also fallen into an error in calling the veber an unit of current, whereas it is an unit of quantity. The error is obvious, and corrects itself; therefore, a little below Mr. Varley says farad $= \frac{\text{veber}}{\text{volt}}$ thereby treating the veber as a quantity of electricity. In Mr. Varley's table either the word "current" should be replaced by "quantity," or the word "veber" should read "veber per second."

TABLE OF UNITS.

B.A. Units.	Names.	Absolute measure.	Common measure.
Resistance	Ohm	10^{7}	1·0468 Siemens's
	Megohm ...	10^{13}	
Electromotive force	Volt	10^{5}	1,046800 Siemens's
Quantity	Veber	10^{-2}	0·9268 Daniell's
Capacity	Farad	10^{-7}	About half-knot cable core
	Microfared ..	10^{-13}	

October, 1870. X. X. X."

THE MANCHESTER, SOUTH JUNCTION, AND ALTRINCHAM RAILWAY COMPANY v. THE QUEEN.

This case raised a question of great importance—whether the Government, under the Telegraph Acts 1868 and 1869, are entitled to take telegraph lines on railways worked by the Electric Telegraph Company under agreements with the railway companies, without compensation to the railway companies, but only by purchase from the telegraph company, treating the railway companies as having no interest entitling them to payment of compensation. It was an appeal of the company from a judgment of three Judges of the Queen's Bench Division (the Lord Chief Justice, Mr. Justice Lush, and Mr. Justice Manisty) against them on a petition of right, claiming compensation under the Telegraph Acts for telegraphs taken by the Post Office. The Act of 1868 (31 and 32 Victoria, cap. 110, section 3) provided that the Postmaster-General might purchase, for the purposes of the Act, the whole or such parts as he should think fit of the undertaking of the Act (which was to mean the whole or any part of the electric and other telegraphs, wires, posts, &c., of any company engaged in transmitting messages for money by means of electric telegraphs), and any undertaking purchased under the Act should be vested in him, and that no such purchase be made and no agreement binding unless the agreement, accompanied by a minute from

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the Treasury explaining it, should have lain a month before Parliament. Then by Sec. 5 any company might sell any portion of their undertaking, and by Sec. 7, "if the Postmaster-General shall acquire any undertaking under the powers of the Act, he shall, on the request of any company possessing an undertaking established by special Act or Royal charter at the time of the Act, purchase the undertaking of the company upon terms to be settled by agreement or arbitration; and that any railway company possessed of a telegraph then open to the use of the public for transmitting messages for money, or possessing any beneficial interest in such telegraph, shall be included in this provision, and be entitled to require the Postmaster-General to purchase." And by the Act of 1869 these provisions were confirmed and carried out, it being enacted that the Postmaster-General was to have the exclusive privilege of transmitting telegrams except such as existed for the private use of any company or person, &c. In 1855 the railway company in this case put up an electric telegraph upon their lines, open for the receipt of telegraph messages from the general public at a rate of 6d. per message. But in 1865 the company entered into an agreement with the Electric Telegraph Company under which that company was to make effective lines of telegraph along the railways of this and other companies, who were to pay part of the expense of construction, the Electric Telegraph Company to maintain the lines and to work them for their own benefit, subject only to the private use of the railway companies, and the railway company accordingly continued to use the telegraphs for their own purposes as before, but the telegraph company used the telegraph lines for their own profit up to the end of January, 1870, when the transfer to the Postmaster-General under the Telegraph Act occurred. Upon the passing of the Act of 1868 the Postmaster-General purchased the undertaking of the telegraph company, the purchase being completed in January, 1870, when the Postmaster-General took possession. In August, 1870, the railway company required the Postmaster-General to purchase the interest of the company in the rights or property of the company for the transmission of telegrams, their claim being for a sum of about £13,000 as compensation in respect of the reversionary interest in the telegraph receipts from public messages (which before the agreement with the telegraph company had amounted to over £1,000 a year), and in respect of the loss of their privilege of granting way-leaves, &c., and in respect of granting a monopoly to the Postmaster-General for the conveyance of telegrams over their railway, and the company also claimed an annual payment of £18 in perpetuity for right of way, &c. The Postmaster-General gave no notice of his intention to purchase the interest of the company, but as the railway company appointed an arbitrator he, under protest, appointed one, and they appointed the Marquis of Salisbury as umpire, and he, in June, 1873, made his award, which awarded to the railway company the sum of £6,479 as compensation, besides an annual payment of £1 per mile per wire, &c., for any additional wires to be fixed by the Postmaster-General. His lordship stated as to the ground and basis of his award:—"The wording of the agreement is, in my opinion, more compatible with a short term than with either perpetuity or a long term. Moreover, the powers given in the agreement to the railway company are such as would have made it almost impossible in practice for the telegraph company to have continued to exercise its rights under the agreement adversely to the wishes of the railway company; consequently I have assumed in my award that the railway company had practically the power of terminating the agreement on short but reasonable notice." The noble marquis added:—"I have been asked to state the assumption on which my award is based in respect to the legal power of railway companies to be or become forwarders of public telegrams for profit. I have made no assumption on this point. If railway companies could not themselves transmit telegraph messages for profit, the alternative of leasing way-leaves to telegraph companies was open to them, and the question whether the railway company in this case could or could not work telegraph business directly for profit is not, in my judgment, an element affecting the amount of compensation which I have awarded to the company. My award does not treat the possibility of a future direct business in telegraphs as one involving sufficient prospect of gain to give a claim for compensation in that respect." The Postmaster-General, however, declined to pay the amount on the ground that the award was bad in law and the arbitration not legally binding; and in March, 1874—now more than six years ago—an action was brought by the railway company to enforce the award. In that action it was agreed that a special case should be stated to raise the question of law; and in June, 1877, the case was stated by Mr. Herschell, Q.C., and in March last year it was argued and determined in the Queen's Bench Division, when three judges (the Lord Chief Justice, Mr. Justice Lush, and Mr. Justice Manisty) gave a decision in favour of the Government, and adverse to the claim of the railway company, being of opinion that the marquis had no power to assess the compensation, as the right to compensation was disputed, and there was no notice by the Postmaster-General to treat, and the submission to arbitration was under protest, a decision from which the company now appealed.

Mr. Benjamin, Q.C. (with Mr. A. Williams), argued for the company in support of their claim; the Solicitor-General (with Mr. Simpson, Mr. A. E. Hardy, and Mr. Casserley) appeared for the Crown in support of the judgment appealed from.

The argument on behalf of the company was that they had in more ways than one "a beneficial interest" in the telegraph lines on their railway, or the right of laying them or allowing them to be laid or used, in respect of which they were entitled to require the Government to purchase their interest and pay them compensation as awarded.

Mr. Benjamin, in arguing the case on behalf of the railway company, said the pretension on the part of the Government—that they were entitled, merely by purchasing the interest of the telegraph company, to deprive the railway company of their rights and interests in the telegraphs without compensation—was extraordinary and untenable; and he contended that in plain sense and justice, and on the true construction of the effect of the agreements between the companies and the intention of the Acts of Parliament, the railway company retained a valuable interest in the telegraphs on their lines, for which they were entitled to compensation, as awarded by the Marquis of Salisbury.

Lord Justice Brett: The suit is really brought to enforce the award?

Mr. Benjamin: It is; but it is not competent to examine into the grounds and reasons of the award, for there is no appeal from an arbitration, and provided the award is within the power of the arbitrator it is good. There is a positive award of a certain sum to the railway company as compensation, and that is sufficient. The award was objected to on the ground that the question of right to compensation ought to have been decided before the amount was submitted to arbitration, and it was on that ground chiefly the Queen's Bench judges had decided. Mr. Justice Manisty said, on giving his judgment, that the award was without jurisdiction, and that the marquis had no jurisdiction to give such an award. In his view the right to compensation was to be determined first where the right to compensation was disputed; and the Lord Chief Justice made a similar observation, that Lord Salisbury had tried the right to compensation, which he had no power to decide. But this was fallacious, for, no doubt, the decision of the marquis was not conclusive and might be controverted in the action, only it was not conclusive against it that it decided the right. The claimant might commence by getting his damages assessed, and then in the action, no doubt, his right to compensation might be disputed; but it was not enough to get rid of the award to say that it had decided the right to compensation. Of course, the right to compensation was assumed on a proceeding to assess compensation; but it would be afterwards contested. Lord Cottenham, in 1849, held that the right to compensation must first be determined, but in 1851 Lord Truro, his successor, dissented from that view, which had ever since been regarded as overruled.

Mr. Benjamin, in continuing his argument on behalf of the company, cited the 7 and 8 Vict., cap. 85, sec. 14:—"Where a line of telegraphs shall have been established by a railway company, the use of snch telegraph shall (subject to the prior right of the Crown and of the railway company) be opened for the sending of messages by all persons." That, he said, was a direct enactment that railway telegraphs should be open to the public, and so at the time of the passing of the Telegraph Act, 1868, those terms were adopted and used in that sense, and brought this telegraph line within the purchase clauses. Then as to there having been no notice by the Postmaster-General to treat for the interest of the railway company, he had taken possession of the telegraph lines belonging to the railway company; for, as the case stated, the Postmaster-General took possession of the undertaking of the Electric Telegraph Company, "including the part of it on the line of the railway company." The Postmaster-General took possession of the telegraph lines of the railway company let to the telegraph company, and succeeded to the position of the telegraph company. That being so, the railway company were entitled to proceed to arbitration under the 68th section of the Lands Clauses Act, which provided "that if any party shall be entitled to compensation in respect of any land or interest therein which shall have been taken or injuriously affected by the promoters of any undertaking, and for which they shall not have made compensation, there shall be a proceeding to arbitration," &c.

Lord Justice Brett: Then you say that either of the companies might have put an end to the agreement by reasonable notice?

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Mr. Benjamin: Certainly, as regarded the agreement originally entered into. There was a second or supplemental agreement as to other wires for a year, and so on from year to year, terminable at six months' notice, which might show what the agreement originally meant. At all events—and this, he said, was enough for his argument—the agreement was clearly terminable, and was not perpetual. That being so, the telegraph company were simply working the telegraph lines for the railway under an agreement terminable at a certain notice. The railway company, therefore, had an interest, and a beneficial interest, which entitled them to compensation. There were three sets of wires or lines on the railway, one of which did not belong to the telegraph company, but was only worked by them; the other two were put up by the telegraph company upon the railway under the agreement. The Postmaster-General came upon the railway and took possession of all the telegraph lines; in short, he took possession of everything and paid the company nothing. The Marquis of Salisbury, no doubt, stated that he had assumed that the railway company were entitled to put an end to the original agreement "on short but reasonable notice," and all that he had considered was that there was a reversionary interest and the power to grant "way-leaves," or licences, to other telegraph companies to put up telegraph wires along the lines, and, cutting down the claim about half, he awarded only half, or £6,769.

Lord Justice Cotton: He has assumed that the original agreement was terminable, whereas the Government say it is perpetual. Are we not to consider whether that was so? Again, he has assumed a power to grant "way-leaves" or licences to other telegraph companies. May we not also consider whether that was so?

Mr. Benjamin: Certainly, the Court can consider whether on these grounds there was any right to compensation, though they cannot enter into the amount.

Lord Justice Brett: That is, if there is no reversion, you cannot have compensation for it?

Mr. Benjamin: Certainly not.

Lord Justice Brett: The sum being an entire sum, how can it be set right if the marquis was wrong as to part?

Mr. Benjamin: The Court cannot divide the sum; it can only be sent back to the arbitrator to be set right. But if there is anything in respect of which the company are entitled to compensation they must be entitled to something. And if the company were entitled they would proceed under the Lands Clauses Act, or under the Telegraph Acts. But even if there had been any error in the procedure, there having been no application to set aside the award on that or any other ground, and the only question reserved having been the right to compensation at all, that was now the real question between the company and the Government, and no other ought to be raised.

Mr. A. Williams followed on the same side, and stated that he had been engaged in most of these cases, and knew that many companies which had proceeded in the same way as the present had obtained large sums as compensation in similar cases and under similar circumstances. Being asked for what the company claimed compensation, he answered for their reversionary interest, upon which

Lord Justice Brett pointed out that the Act of 1869 had taken it away by giving the Postmaster-General for the future an exclusive right of using the telegraph lines.

The learned counsel, in answer to this, urged that it would be strong to hold that a subsequent enactment establishing a monopoly had repealed by implication an enactment giving a right to compensation.

Lord Justice Brett pointed out that in a recent case (the Newport Railway case) it had been so held, upon which

Mr. Benjamin said he should ask their Lordships to overrule that case as being wrongly decided.

The Solicitor-General then addressed the Court on the part of the Crown in support of the judgment of the Queen's Bench judges. If, he said, the award of the Marquis of Salisbury was bad as to any part of it, or any of the grounds of claim, then, as it was for one entire sum which could not be divided, it was bad *in toto*, and could not be supported; and the marquis had expressly given his award in respect of all the grounds of claim made by the railway company. And what was the claim? It was for compensation in respect of the reversionary interest in the telegraph receipts from public messages and the loss of the privilege of granting way-leaves to other telegraph companies, and in respect of granting a monopoly to the Postmaster-General for the conveyance of telegraphs over their railway; and the notice of claim was "to purchase such interest as the company is entitled to either in possession or reversion in any rights, powers, privileges, and other property of such company acquired or used for the transmission of telegrams so far as the same are or can be used for the transmission of such telegrams for commercial purposes." And this was a notice given under the Act of 1869, "but without prejudice to any right which the company may be entitled to under the Act of 1868." What the company really asked compensation for could hardly be made out; but they clearly meant to reserve to themselves their use of the telegraph wires, claiming compensation in respect of a reversionary interest. The claim was put as under the Act of 1868, but the arbitrator had awarded in respect of a claim of compensation under the Act of 1869. The claims were such as could only exist under the Act of 1869; and this put the company in an inextricable dilemma, for the monopoly was only created under the Act of 1869, and yet the claim was under the Act of 1868. No monopoly was contemplated under the Act of 1868. The company, it was said, had a beneficial interest in the commercial telegraph business; but it had no such interest at the time the Act passed, for it must have been such an interest at the time the Act passed. The words were "any beneficial interest in such telegrams"—that is, telegrams sent for the public for money. In such telegrams the company had no such interest.

At the close of the arguments their Lordships proceeded to give judgment in favour of the Crown, affirming the judgment of the Queen's Bench judges against the company:—

Lord Justice Brett, in giving judgment, said it had been objected that the arbitration had not been properly commenced, and that the award of the marquis was beyond his jurisdiction, and that if not bad altogether it was bad as to part, and being for an entire sum was bad *in toto*, as to which he was of opinion that it could not in that case be sent back to the marquis to be be corrected and set right, an action having been brought upon it. Under the Act of 1869 there was no ground for compensation, as the Postmaster-General had only taken possession of the "undertaking" of the telegraph company; and under that Act the railway company was not entitled to require the Postmaster-General to purchase any interest belonging to it. It was not "a telegraph company," nor engaged in sending telegrams for money," within the terms of the Act. It had relinquished the business to the telegraph company. Therefore, it was not entitled to require the Postmaster-General to purchase any "interest" it might have. That of itself was enough to show that the arbitration could not properly be commenced under that Act; nor had the conditions of such an arbitration been complied with, for the Postmaster-General had given no notice to the company of an intention to treat for the purchase of their interest. The arbitration, therefore, could not be supported under the Act of 1869. It had been suggested that it might be supported under the Act of 1868, or under both the Acts taken together. But here again the question arose whether the railway company were within the Act of 1868 and entitled to call upon the Postmaster-General to purchase, and he thought they were not, for they were not "a telegraph company," nor "possessed of a telegraph open to the public for transmitting messages for money," nor "possessed of any beneficial interest in such telegraphs"—that is, at the time the Postmaster-General was called upon to purchase their interest, in 1870—for he could not be called upon to purchase an interest which they had transferred. The company, then, had no "beneficial interest" in the transmission of messages for money, although they had a right to have their own private messages sent free or at half price. That was a "beneficial interest," but not a "beneficial interest in sending messages for money." This was a fatal objection to the arbitration. There was not, either under one Act or the other, any authority to enter upon it, and it was entered upon without jurisdiction. But even if there was any jurisdiction it had been exceeded, because compensation was awarded for something not the proper subject for compensation—that is, for a supposed reversionary right of the railway company to resume the right of sending messages for money—and it had no such reversionary right, for it had no power at any time to resume the sending of telegrams for money. The company had deprived themselves of any such power, for the agreement with the telegraph company was perpetual—that is, it had no provision for its termination by notice or otherwise, and in its terms it applied as long as the two contracting parties continued to exist. It was said that as no time was mentioned it was to last for a reasonable time or until reasonable notice; but that was quite a new doctrine, and never yet heard of, where there was nothing in the agreement from which any such condition could be implied. There was, therefore, no reversionary interest in the company. Legislation had, moreover, taken place prior to the demand for purchase—that is, in the Act of 1869, which gave the Postmaster-General the exclusive power of sending messages by telegraph for money. By virtue of that statute, therefore, even supposing the agreement with the telegraph company was temporary, the railway company never could have resumed the transmission of telegrams for money. The statute effected that result, and it contained no provision for compensation. It was presumed to be for the public benefit, and parties deprived of any-

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thing must submit to the loss. It followed that in respect to this supposed loss of the future power of sending messages for money there was no ground for a claim of compensation. That being so, as it was quite clear that the marquis having given compensation for this supposed loss, there was an excess of jurisdiction (even assuming any jurisdiction to exist), and the award being clearly bad as to part, it was bad altogether, and, therefore, formed no ground of action, and so the judgment of the Queen's Bench Division was right, and must be affirmed. Lords Justice Cotton and Thesiger concurred in this ruling.

SOCIETY OF TELEGRAPH ENGINEERS.

MEETING OF THE 28TH INST.

Professor AYRTON read a note by Mr. W. Andrews, showing that the current producing an electric light is proportionate to the "crater," or hollow, in the positive carbon. A table was given showing that the values obtained by measuring the surfaces of the crater were very nearly in the same ratio as the values of the currents in webers per sec., as measured by the galvanometer.

The SECRETARY next read a paper by Mr. Oliver Heaviside on "The Resistance of Galvanometers," which covered some of the ground taken up by M. du Moncel in the translation of his paper, which we publish this week.

The paper next read was the following :—

ON THE DETERMINATION OF THE POSITION OF THE FAULTS IN A CABLE WHEN TWO EXIST AT THE SAME TIME.

BY CHARLES HOCKIN, M.A.

[Abstract of paper, without formulæ, as read by the Secretary.]

It is known to every electrician that if we have at command each end of an insulated copper wire, and if at one point, and at one point only, imperfect insulation exists, the determination of the position of that point is comparatively easy, because the accuracy with which its position can be determined depends solely on the electromotive force that can be produced between the ends of the conductor in question, and upon the sensitiveness of the instrument that is employed to determine the presence or absence of current in one branch of the connections used.

If, on the other hand, one end only of the conductor is at the command of an observer, the difficulties are greatly increased, so greatly that, if the imperfect insulation at the weak point of the cable, or, in other words, the conducting power at the fault, does not bear a very large ratio to the slight leakage that always must exist (even in the best insulated cables) through the uninjured insulating material, the determination of the position of the fault becomes practically impossible.

The reason of this is well known. The difficulties arise in the first place from the fact that, one observer only being at hand, he must make two observations at the same instant if he is to determine with absolute accuracy the two unknown elements in the problem before him, namely, the position of the fault in the cable, and the amount of conduction through the fault at the instant of observation.

I know no method of fulfiilling these conditions. The nearest approach to a fulfilment of the conditions is, I believe, to observe in any convenient manner the effective resistance offered by the conductor, insulator, and fault to the passage of a current from the end of the cable at the command of the observer to earth, and immediately after this observation is completed, to measure the amount of electricity due to the statical charge in the cable that flows through the end of the cable when it is connected to earth through a conductor of a resistance so slight that it may be disregarded in comparison with any other resistance in the circuit of the cable and connections.

This method has two principal inconveniences :—

First, the time in which the cable can discharge through the fault the greater portion of the electricity that it holds is usually very small, and is commonly a fraction of a second only, sometimes a very small fraction of a second. Therefore, to determine the proportion of the charge that would flow through the near end of a cable connected through a conductor of small resistance to earth immediately after the observation of resistance is made, requires that a key be employed that changes the position of a contact piece from a position in which it makes good connection with one conductor to one in which it makes good connection with another conductor in a space of time measured by a minute fraction of a second. There is a special difficulty in this, as has been proved by some experiments as yet unpublished, which I learn have been made with Mr. H. A. Taylor's chronograph.

This difficulty is not, however, serious in the case of a cable of considerable length, say of some hundred miles.

The second difficulty is that we do not know for certain that the resistance of the fault remains constant during the short time of discharge. The electromotive force tending to drive electricity across the fault varies during the discharge (earth currents apart) from its maximum value to zero, and under these conditions the resistance of the fault may vary. Experiments on this point are difficult, but would, I believe, be very useful. They require costly apparatus, or the command for a considerable time of a cable of some length which, we will hope, would be more costly still.

The method commonly employed is to make successively two observations of resistance, each of which occupies a time measured not by *fractions of a second* but, under the most favourable circumstances, by a minute, or no small fraction of a minute. At the time of the observation the electromotive force at the fault is varied necessarily by the variation of the connections at the far end of the cable, and the resistance of the fault is often greatly altered by this circumstance rendering the observations of little value.

On the other hand, if two observers are at hand, one at each end of the cable, methods for the determination of the position of the fault, theoretically perfect, are well known.

These methods require that the two observers should possess a standard of electromotive force by which they can compare the electromotive force of the batteries that they have at command, or an equivalent current measurer with their standard of resistance.

Clark's cell is a suitable standard of E.M.F., and the details of the method are well worth working out. Many suggestions on the point have been made of late, particularly the method known as M. Lenoir's method.

After saying so much as to the difficulties attending the determination of the position of one fault, it may seem somewhat rash to suggest a method for the determination of two co-existant faults.

There is an insuperable difficulty if resistances and currents only are measured, because the number of such measurements is limited, and so many relations necessarily exist between the values in question that they furnish but one independent relation between the two quantities to be determined, namely the positions of the two faults.

Suppose even that the resistance of neither fault is altered by the amount or direction of the current flowing through it, and suppose that each end of the cable is at the command of an observer. Call the ends of the cable A and B. He can measure—

1. The resistance of the cable from end A freeing end B.

2. The resistance of the cable from end A putting end B to earth.

3. The resistance of the cable from end A and the potential at the same time at end B insulated.

4. The resistance of the cable from end A and the current that flows at the same time to earth through end B.

5 to 8. These observations may be repeated reversing the ends A and B.

9. He may measure the total resistance of the circuit, both ends being free.

10. He may loop the two ends and measure the resistance to earth with these connections.

11. He may measure the ratio of two resistances such that when connected together at one end, and at the further end one with end A of the cable, the other with end B, no electromotive force exists between the ends A and B when an E.M.F. is applied to the joined ends of tae resistances. Thus determining the position of a "resultant fault" by the bridge method.

In this way eleven quantities are measured, six of resistance, two of current, two of potential, and one of a numerical ratio (or its equivalent). Each of these eleven measurements furnishes a relation between known quantities and the four unknown quantities, the resistance of the two faults, and their two positions in the cable.

It was not to me at first apparent that these eleven relations yield only one relation between the quantities determining the positions of the two faults, and that in consequence eight relations necessarily exist between the quantities measured. The proof of this is, of course, simple, requiring only the elimination of two unknowns between a system of equations, essentially of the first degree. I do not know, however, that the results have been published, and therefore present them to the society as setting to rest, perhaps, a question that has once or twice been raised.

The method I have to propose for the determination of the positions of two co-existent faults is a combination of the method of discharge with that of simultaneous observation at each end of the cable.

One observer at end A of cable measures its resistance, the

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observer at end B at the same time insulates his end of the cable, and measures the potential there. Immediately that these measurements are completed, end A is put to earth through a conductor of low resistance, and the total discharge from the cable is measured at the end A.

From the three observations thus made, as nearly as may be simultaneously, three relations may be written down connecting the resistances of the two faults and the two quantities determining their positions.

From these three equations, or relations, the quantities expressing the resistances of the two faults may be eliminated, and there results one relation between the positions of the two faults and the three quantities measured. This relation would be absolutely true if the resistances of each fault remained constant during the discharge. Next the observations first made at end A may be made at end B, and the observation first made at end B may be made at end A.

By these observations a second relation is found bewteen the positions of the two faults in the same manner as in the first case.

We have now two independent relations between the quantities expressing the position of the two faults; and from these two relations the position of each fault may be determined.

The relations just mentioned each lead to equations of the third degree between the quantities to be ultimately determined, and the solution of the equations cannot be expressed in an algebraical formula.

The simplest way of solving them is by trial. The necessary conditions of the problem give at once certain limits with in which the quantities to be determined certainly must lie.

Take the greatest of such limits to express the distance from A of the fault nearest to that end, and calculate from the *first relation* in question the corresponding distance between the two faults. We then know the corresponding distance from the end B of the fault nearest to that end.

Substitute the quantity in the *second relation* above-mentioned, and calculate the resulting distance between the faults. If this resulting distance is the same as that yielded by the first relation in question the problem is solved, if not a second trial must be made and so on. If we adopt the plan of first trying the greatest and then the least possible value of the position of any one fault, and then a value half way between that value and that one of the maximum or minimum values between which the position of the fault really lies, we shall, in ten trials at the most, arrive at a value correct within one part in a thousand, or as correct a value as could be obtained from the nature of the observations which have to be made.

The arithmetical labour of these calculations is not great, and I have put the formula in as convenient a form as I can for arithmetical calculation.

There remain the difficulties arising from the presence of earth currents. These are eliminated from the measurements of potential and earth current as far as possible by the methods of "reading to a false zero."

To eliminate the effect of the earth current on the discharge from the cable requires a little calculation which is not difficult if the motion of the galvanometer needle is rendered sufficiently free. The proper formula for this is given in the paper which will be submitted to the Society in the *Journal*.

Mr. KEMPE then read a paper on "Testing by Received Currents," in which the system of testing employed in India was referred to, and that adopted by the Post Office authorities in this country was described at considerable length.

It was observed by the PRESIDENT, subsequently to a short discussion on this paper, that it often happens that there is not a single fault on all the lines worked by the Post Office in the United Kingdom.

The meeting then adjourned until May 12, when a very interesting communication on improvements made in dynamo-electric machines, and on the effect of light upon vegetation, is expected to be read by Dr. C. W. Siemens.

WEST COAST OF AMERICA TELEGRAPH COMPANY (LIMITED).

The ordinary general meeting of the above Company was held on the 23rd April at the offices, Cannon-street, under the presidency of Mr. A. R. Johnston.

The SECRETARY having read the notice convening the meeting,

The CHAIRMAN said it was a matter of regret to the Board that they were unable to present the shareholders with the usual statement of accounts, but circumstances which were quite beyond their control had occurred to prevent it. When they last met, about a year ago, the Company's cables were in thorough working order, and they were doing a fair business. The war between Chili and Peru had just broken out, and they were in hopes that their cables would not be interfered with. In that hope, however, they had been disappointed, and as a matter of course their earnings had suffered very materially. The first cable which was cut was that between Iquique and Antafogasta, which was cut on the 18th of April last year. Their earnings in the first four months of that year amounted to £12,450, but that rate was somewhat above the average on account of messages being transmitted which were connected with the breaking out of the war. The average monthly earnings were therefore about £3,112, but afterwards they fell down to £1,025. They had no account yet of the working for December. They had, however, information to the end of November, and the earnings for those seven months were only £7,600, giving an average of £1,086 per month. They had a claim on the Chilian Government for that loss, and their agent was in constant communication on the subject with the Chilian Government, who had promised to give it their future consideration. The Government were well known for their straightforward views. Other sections had also been broken, but the ship had been engaged in repairing them. When they last met they stated that they were sending out the Retriever, as it was actually necessary for the Company, and they had so constructed her as to carry water, to be engaged in towage, and all that kind of work. They were in great hopes that she would more than pay her expenses, and no doubt she would have done but for the exceptional state of matters. They entered into arrangements for carrying water, which would have been a very good thing for them, only in consequence of the war that had come to an end. She made £1,600 in a salvage job, and she had earned £1,140 in freight, but still the total loss on her working was altogether £8,000. As the accounts had not arrived, it would be necessary to adjourn the meeting, and he accordingly moved that it be adjourned to the 4th of June.

Mr. KENDAL seconded the motion, and asked whether there would be any extra expense on account of the exceptional state of affairs.

The CHAIRMAN, in reply, said that he did not think there would be. They were able to borrow the money which would be required to pay the debenture interest, the deficiency on which would only amount to £5,200. They had tried to obtain employment for the ship, but had not been successful, because she was built for telegraphic purposes more than for the purpose of carrying freight.

The resolution was carried, and the proceedings terminated.

THE BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).

Abstract of the report of the directors to the thirteenth half-yearly general meeting, to be held 7th May, 1880, at the Cannon-street Hotel:—The directors submit the annexed accounts and balance-sheet for the half year ended 31st December, 1879. The revenue for this period amounted to £77,504 15s. 8d.; the working expenses to £11,494 5s. 2d., leaving a balance of £66,010 10s. 6d.; to this is added £1,600 4s. 7d., brought forward from the 30th June, 1879, making a total of £67,610 15s. 1d. After deducting income-tax, £889 2s. 2d., there remains a balance of £66,721 12s. 11d. First and second interim dividends amounting to £32,500 have been distributed, leaving the sum of £34,221 12s. 11d. to be carried forward. The company's cables continue in good working order. The shareholders are aware that for some time past the directors have been endeavouring to obtain certain variations of the working agreement with the Western and Brazilian Telegraph Company, the main point being an alteration of the proportions of gross receipts exchanged between the two companies. The board were advised by eminent counsel that this matter was within the powers of the arbitrator to be appointed under the agreement, but the Western and Brazilian Company disputed the claim, and the question has now been decided by the Queen's Bench Division of the High Court of Justice and by the Court of Appeal in favour of the Western and Brazilian Company. Two other of the claims of this company have been assented to, and the Court has appointed an arbitrator to decide upon the only remaining question. It is probable, however, that an arrangement will be come to on this head, and the expense of arbitration avoided.

TELEGRAPH SHARE LIST.

Companies.	Closing Prices April 28.		Business Done Week Ending April 28. Highest.		Lowest.	
Anglo-American Ordinary	60¾,	1¼	61⅛		60¼	
Do. "B"	90,	⅛	90⅜		89⅛	
Do. "A"	34,	⅛	34⅛		33¾	
Brazilian	7 13-16,	15-16	7 15-16		7¾	
Cuba	9⅜,	10⅛	—		—	
Do. Ten per Cent. Pref.	16¼,	¾	—		—	
Direct Spanish	1⅞,	2¼	—		—	
Do. Ten per Cent. Preference	10½,	11	10¾		10⅜	
Direct United States	11 7-16,	9-16	11⅛		11⅜	
Eastern	8 13-16,	15-16	9 1-16		8 13-16	
Do. Six per Cent. Debenture	102,	5	103		103	
Do. Five per Cent. do.	102,	4	103		103	
Do. Six p Ct. Preference	12¼,	⅜	12⅛		12¼	
Eastern Extension	8 15-16,	9 1-16	9¼		8 15-16	
Do. Six per Cent. Deb.	106,	9	109		109	
German Union	8⅞,	9⅛	9		9	
Globe Telegraph & Trust	5½,	6	6		5 13-16	
Do. Six p Ct. Preference	11 9-16,	11-16	11¾		11⅜	
Great Northern	9⅝,	10⅜	10⅜		9⅞	
Indo-European	24,	5	—		—	
Mediterranean Extension	3,	⅛	3⅛		3¼	
Do. Eight per Cent. Preference	10½,	11½	—		—	
Reuter's	10,	11	—		—	
Submarine	235,	8	—		—	
West India and Panama	1 15-16,	2 1-16	2		1 15-16	
Do. Six per Cent. Preference	7⅞,	8⅛	8⅛		8	
Western and Brazilian	8,	¼	8⅝		7⅞	
West. Union Seven per Ct. 1st Mt.	120,	5	—		—	
Do. Six per Ct. Sterg.	102,	4	—		—	

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SLIP

THE NEW FRENCH ATLANTIC CABLE.—We understand that this cable is interrupted.

ANOTHER ELECTRIC LIGHT COMPANY.—The Vandepoele Electric Light Company of Detroit has filed articles of association. The capital stock is 125,000 dollars.

THE MANILLA CABLE.—This cable, manufactured by the Telegraphic Construction and Maintenance Company, was successfully laid by the ss. Calabria on April 30.

A NEW PRINTING TELEGRAPH has been invented by Herr Divite, of Bremen, which requires no synchronous driving gear, the type wheels in it only turning step for step.

THE TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.—We notice that a gold medal has been awarded to this company for their excellent show of cables at the Sydney Exhibition.

MANCHESTER AND THE TELEPHONE.—The question of telephonic and telegraphic wires is exciting considerable attention in Manchester, and has been referred to a committee to report on the whole question.

TELEPHONIC EXTENSION IN AMERICA.—The telephone is being carried into the mountains of Kentucky. There is now a scheme on foot to construct a line from Louisa, Lawrence County, to Paintsville, Johnson County.

AMERICAN TELEPHONE COMPANIES.—The American *Journal of the Telegraph* announces that the Gold and Stock and New York Bell Telephone Company are negotiating with a view to consolidation of interests in the formation of a new company.

THE SOCIETY OF TELEGRAPH ENGINEERS.—The next meeting will be held at the Institution of Civil Engineers, 25, Great George-street, Westminster, S.W., on Wednesday, May 12, when C. W. Siemens, D.C.L., F.R.S., past President, will read a paper "On the Use of the Dynamo-Electric Current in Horticulture and in Metallurgy."

THE CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The number of messages passing over the lines of this company during the month of April was 2,711, estimated to produce £3,100, against 2,670 messages, producing 3,140 in the corresponding month of last year. The traffic receipts for the month of February, estimated at £3,200, realised £3,140.

THE WORK PROPOSED BY THE MEXICAN TELEGRAPH COMPANY.—A company has been organised under the laws of the State of New York, to be known as the Mexican Telegraph Company, having for its object the establishment of telegraphic communication with Mexico, Central and South America, and ultimately with New Zealand, Australia, China, and Japan.

ROYAL TELEGRAPHING.—"The Duke of Edinburgh landed at Valentia at three o'clock yesterday afternoon. He was received by the principal inhabitants, and a relief deputation from Valentia, Cahirciveen, and Portmagee waited upon his royal highness, who afterwards visited the Anglo-American Telegraph Cable Station, where arrangements had been made by the superintendent to enable him to communicate directly with the Princess Louise at Ottawa. Congratulatory despatches were very quickly exchanged."

THE ELECRIC LIGHT.—Makers anticipate a large business in electric lighting apparatus during next winter. Last winter there was a revulsion of public feeling against the light, and the sale of plant was rather slack. Nevertheless we hear that Messrs. Siemens Bros. have turned out over 1,000 apparatus, about 500 of which have been used in Britain, and 500 abroad, chiefly in Russia. The lighting of the New Victoria Docks permanently by thirty of Siemens lamps will be the next important undertaking of the kind.

DEATH FROM ELECTRIC SHOCK.—The *Scientific American* recounts how a gentleman was recently induced to try an electric shock "just for fun" from the machine of one of those peripatetic electricians sometimes seen, as it appears, in America as well as in England. On receiving his charge the victim walked away, but had not gone far when he was seen to stagger and fall. He was picked up unconscious and remained so until he died, two days after. The physicians pronounce it a case of apoplexy brought on by an electric shock.

GREAT NORTHERN TELEGRAPHS.—The recent report from Copenhagen to the effect that Baron Mohrenheim, the Russian minister, had left Copenhagen for St. Petersburg to arrange the details of the purchase by Russia of the Asiatic lines belonging to the Great Northern Telegraph Company, is declared by Mr. Erichsen, the company's representative in England, to be utterly at variance with facts. He states that the company never contemplated a sale of their Asiatic lines, and that no negotiation to this effect has ever directly or indirectly been carried on between the company and the Russian Government.

SIMPLE APPARATUS FOR SHOWING ELECTROLYSIS OF WATER.—A glass bolthead of 30 or 40 oz. capacity is stopped with an india rubber cork carrying two glass tubes, which contain hermetically-sealed platinum wires projecting an inch at the inner end, and terminating in binding screws at the other. The vessel is filled 1-5th full of acidulated water, boiled, and the stopper inserted to cause a vacuum when cold. On connecting with two "Grove" cells, the bubbles of gas so expand as to make the whole liquid appear to boil. With either a single "Grove," "Bunsen," "Bichromate," or "Leclanché" cell continuous decomposition may be obtained. When sufficient gas has collected to impair the vacuum, it may be restored by boiling.

CITY AND GUILDS INSTITUTE.—The following is the syllabus of lectures on the electro-deposition of metals, being lectures 7 to 12 of the evening course:—Relation of energy of chemical action to other forms of energy; general principles of generation of electric currents by chemical action. Construction of different galvanic batteries; explanation of chemical principles involved in their working; polarisation. Laws of electrolysis. Conditions on which the deposition of pure metals depend. Solutions used in electro-depositing various metals; their preparation; influence of varying conditions on the character of the deposit. Cleansing and preparing articles to receive deposit. Methods of testing purity and strength of depositing solutions. Insulating materials.

FIRE THROUGH THE USE OF THE ELECTRIC LIGHT.—The use of the electric light has not proved a safeguard against fire, for one night last week a fire was found to be raging in the lower part of the premises of Messrs. Samuels, the clothiers of Ludgate-hill. The firemen, on going to the spot, found that the flames were due to an escape of gas from a gas engine which supplies the electric light, and a well staircase with which the building is constructed acted as a flue, and carried them through the building. A good deal of damage was done, but the fire was ultimately subdued. We may, perhaps, be told that the fire was owing to the use of a gas engine, and not to the electric light. The engine, we take

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it, is part of the apparatus required. The moral is that great care is necessary in the fixing of the apparatus.

SEEING BY ELECTRICITY.—Touching the letter of Professors Perry and Ayrton, Mr. J. E. H. Gordon writes to *Nature* describing a repetition of Dr. Kerr's experiment made by him a year or two ago. He used an electro-magnet consisting of an iron bar 2ft. 4in. long and $2\frac{1}{4}$in. diameter, surrounded by 70lb. of wire, and excited by ten Grove cells. The total *double* rotation produced, not by slightly altering the resistance but by reversing the current was never more than 26 minutes of arc. To see this at all by a very delicate Jellett analyser it was necessary for the observer to increase the sensitiveness of his eye by sitting in total darkness for some ten minutes before each observation. Mr. Gordon then points out how little chance there is of obtaining visible changes of illumination with "little" magnets, and mere variations in a current not powerful enough to fuse a selenium resistance.

AN ELECTRIC FURNACE.—Dr. C. W. Siemens has experimented for some time with an electric furnace for the purpose of melting in considerable quantities highly refractory metals, such as platinum iridium and steel. In a small one recently exhibited before the Royal Society the positive electrode, which was made of iron, entered from below the crucible containing the metal to be melted, the negative electrode (a rod of carbon) was attached by a lever to a solenoid regulator. The crucible was surrounded by charcoal contained in a copper vessel to prevent loss of heat and the intense heat obtained from the electric current melted 2lb. of broken files in twenty minutes. The arrangement may easily be applied on a large scale; and electric fusion has, it is claimed, the advantages of excluding the atmosphere and the products of combustion from the substance in the crucible. But how about the volatilised carbon from the electrode?

THE PUBLIC AND THE POSTAL TELEGRAPH DEPARTMENT.—The following letter appeared a few days since in *The Times*, from Dr. Holman:—"Sir: I hope you will not desist from attempting to remedy the existing inconveniences of the present telegraph arrangements. They press very hardly on the general public, but especially on the sick. I send you my own experiences within a very few weeks. A lady resident five miles from Reigate sends a message off at 7:55 p.m., asking her medical attendant to come to her in her confinement. This goes to London and reaches Reigate next morning, between 8 and 9 o'clock. A message is given in at Kensington between 8 and 9 o'clock on Saturday evening, and double fee charged to insure speedy delivery. This message is received at 8:20 on Sunday morning. Yesterday a message is given in at 11:15 a.m. in Brighton and I receive it this morning at 8:15.—C. HOLMAN, M.D."

PICTURE OF A THUNDERSTORM.—"And now came the crisis. It seemed as if Nature had determined on one of her grandest pyrotechnic displays. First, at some distance from us, came down a long shaft of lightning, like an inverted rocket; and a roar of thunder, like a volley from a thousand cannon, followed. Quick, and quicker, after this, in every direction and in every imaginable shape, the flashes succeeded one another; and still louder and more terrible grew the thunder with each. Sometimes they shot into the woods in white-hot balls. Anon they zig-zagged, assimilated to the fantastic forms of the naked oak branches among which they fell. Now would descend a screw-like shaft, twirling in its course, yet apparently definite in its aim at some object below. Next might be seen others more like flying serpents, darting and taking their sinuous way from fold to fold of the owering mass of clouds; whilst the notched, scarred, gnarled, crinkled, and gaunt old trees wildly flung out their arms as if to snach and bring them down. Altogether it seemed as though we had got into a strange but antiquated realm of powerful beings, whose delight was in the war of elements, the wreck of matter, and the crush of worlds."—A.M.

FONVIELLE'S "DISCOVERY."—Mr. Robert Sabine writes to us "that the method of passing alternate currents through a galvanoscope coil so as to continuously rotate the magnet was tried many years ago by Professor Wheatstone with a view to construct an electro-magnetic engine, but failed. I believe Mr. Hjorth repeated the attempt with a like result. In 1860 Dr. Werner Siemens applied the principle to the movement of a current reverser which he called a 'Wippe.' In 1869 Mr. A. Stroh took out patents for the application of the system to clock movements. His English patent is dated October 18, 1869, No. 3,028." The passage in this patent describing the application in general terms is as follows:—"My fourth improvement consists of a method of propelling a train of wheels connected with the hands of a clock by means of the continued rotation of one or more magnetised needles, acted upon by galvanometric or other electro-magnetic coils, through which alternately inverted currents are transmitted by a driving clock. By means of this contrivance the escapements employed in telegraphic clocks, as hitherto constructed, are dispensed with, and the motions of the hands are perfectly continuous." The patent then goes on to describe in detail the arrangements for this purpose. One consists in passing the currents through a galvanoscope coil, so as to continuously rotate a magnetic needle within it, the other passing the current through a coil wound on a soft iron disc, and thereby causing two needles to rotate; the rotation in both cases being made to gear with the train of wheels moving the clock hands. We may add that M. Jamin explains the rotation in question by the fact observed by Henry that the magnetisation produced in the disc by the direct current is greater than that due to the inverse current, and that as a consequence the forward and backward impulsions given to the disc alternating current from the Ruhmkorff are unequal; hence the continuous rotation which results. Were the two currents equal, the disc would come to a stop. M. Fonvielle questions this explanation on the ground that he has not obtained the rotation with an induction bobbin having a very long induced wire, which would accentuate the inequality mentionby M. de Jamin.

PROFESSOR TYNDALL ON LIGHT.—Professor Tyndall, in his third lecture at the Royal Institution on "Light as a Mode of Motion," spoke of Newton's supposition that the different colours of the spectrum were due to particles of different sizes "striking" the eye, and to the change, after much opposition, among men of science to the view that the colours are due to waves of different lengths, all travelling at the same rate, but reaching the eye with different rapidities of impact. At the red end of the spectrum are calorescent rays of which the unaided eye is unconscious, and at the other are fluorescent rays (illustrated in the last lecture) of which the unaided eye is also unconscious. The next subject taken up was a discovery of Kirchoff's that the vapour of incandescent bodies cuts off the "bands" in the spectrum of which the body itself gives the bright lines. This was experimentally shown with sodium and lithium, the vaporisation of lithium being effected by a calcium crucible devised by Professor Dewar, and the heat being originated by a magneto-electric machine recently presented by Mr. Siemens. The successive steps of the proof of the undulatory theory of light were then spoken of, together with the difficulties the early experimenters had

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in originating ideas of filling space with a vibrating medium now apparently so natural to us, and the help that the discovery of the polarisation of light had in showing the direction of waves of light. Erasmus Bartholinus wrote on the double refraction of Iceland spar in 1669. Huyhgens followed the work up. Newton held that beams of light had "sides," and Huyghens strove to account for this on the undulatory theory. Malus in 1808 observed the effect of Iceland spar on looking at light reflected in the garden of the Luxembourg; and in 1813 Seebeck discovered that polarisation of light was effected by tourmaline. The word "polarisation" was introduced in 1811. Several experiments with polarised light were shown to illustrate the way in which light thus thrown into one line only of vibration gave evidence of the correctness of the undulatory theory, and showed how the directions of those vibrations could be ascertained.

Atmospheric Polarisation and the Influence of Terrestrial Magnetism on the Atmosphere.—H. Becquerrel, in the *Journal de Physique*, No. 98, February, 1880, pp. 51-56, says:—"The philosophers who, from the time of Arago, have busied themselves with atmospheric polarisation have concluded that the plane of polarisation of the light sent from any point of the sky passed through the sun, or was perpendicular to a plane passing through that luminary. M. Becquerel was led to think that this coincidence did not generally exist, so that he undertook the problem of determining exactly the relative positions of the sun and of the plane of polarisation. After accumulating the results of two years' observations he has come to the conclusion that if we call a plane passing through any point of the sky the eye of the observer, and the centre of the sun the *sun's plane*, then that there is a variable angle between that plane and the plane of polarisation of the light coming from the particular point looked at in the sky, such that the plane of polarisation is always below the sun, that is, between it and the horizon. If the point looked at be north or south, and near the horizon, the angle is small in the early morning, reaches a maximum about 9 or 10 a.m., becomes nought at noon, reaches another maximum at 2 or 3 p.m., and becomes nought again at sunset. Towards the east or west no exact coincidence of the planes is observed, but there is a minimum about noon. In the morning and evening the angle between the sun's plane and the plane of polarisation is tolerably large, as much as 6°; but near the time of coincidence there are perturbations which have prevented M. Becquerel following the movements the plane of polarisation near sunrise and sunset. All the phenomena observed lead to the conclusion that the plane of polarisation is twisted in the positive direction as seen by a person with his head towards the north and his feet towards the south, and that in the region perpendicular to the dipping needle the plane of polarisation suffers practically no twist. The author is, therefore, led to the conclusion that this rotation of the plane is due to terrestrial magnetism. Certain investigations, not yet concluded, have enabled him to calculate *a priori* the possible amount of rotation producible by the earth's magnetism when the thickness of air through which the light comes is known. This thickness has, of course, not been accurately determined; but by making certain hypotheses he has arrived at the result that the probable theoretical amount of rotation of the plane of polarisation due to terrestrial magnetism is of the same order as the observed value. At the same time, the theoretical value is too small to enable him to conclude that terrestrial magnetism is the sole cause of the observed rotation."—*Jnl. Soc. Tel. Eng.*

The Lancashire Telephonic Exchange.—When the telephone was first introduced into this country but a few years ago, its possible practical use was very seriously questioned. It was considered very interesting as a scientific curiosity, but grave doubts were expressed when it was suggested that it might ere long be brought into general operation in business circles as a means of rapid communication between firms all over our large towns. Gradually, however, the telephone made its way. Improvements were effected in it, and in a great many offices—the *Daily Post* among the number—it has been in successful operation for a considerable period. By and by telephonic exchanges were established, by means of which subscribers not only have their own private wires between their places of business, but can be put in immediate communication with any other of the subscribers with whom they may desire to have telephonic conversation. The Lancashire Telephonic Exchange, which was formed about six or seven months ago, and which is connected with the London Telephonic Exchange, has been peculiarly successful in attracting to it subscribers both in Manchester and Liverpool. The offices of the "Liverpool centre" are at F. 13, Exchange-buildings, and form a connecting link between some 200 subscribers, whose offices are scattered all over the town, and some of them distant from the centre some two or three miles. The system of telephone used is the Bell system, one advantage of which is that whilst receiving a message from the other end the receiver has at least one of his hands at liberty with which to note down if necessary the substance of the communication being made to him. If desired, the instrument can be fitted into a movable case, which the subscriber may have on his desk before him, and thus be enabled to carry on a telephonic conversation without moving from his chair. A visit to the operating room of the "Centre" proves very interesting, and the visitor is at once struck with the promptitude with which subscribers are put in communication with each other. Some half-dozen young ladies are sufficient to keep up the conversations between the subscribers, and, in fact, could work at least double the number of wires over which they now have control. Each subscriber is known by his number, and plates with each subscriber's number are ranged on a large frame, each plate having attached to it the wire running from the subscriber's premises. When one subscriber wishes to communicate with another, his number on the frame falls over on a hinge, and the operator having ascertained the number with whom he wishes to communicate, rings up that subscriber, and connects the two wires, the result being that the communication with the operator's table at the "Centre" is at once stopped, and the conversation between the subscribers goes on simultaneously with dozens of other conversations. The whole is done with marvellous quickness, and the only delay experienced is when subscribers are not at hand when called upon. When the conversation is concluded, both numbers drop out of the frame, and the communication is then removed. Some idea of the extent to which the subscribers avail themselves of the telephone may be formed when we state that, out of 200 of them, something like 1,500 and 1,600 "calls" are made in one day. No difficulty is experienced in hearing what is said through the telephone; even the ticking of a watch or a deep-drawn sigh being audible from any distance now covered by the "Centre." There is every probability of telephonic communication being ere long established between this city and Manchester, and it is even claimed for the Bell telephone that sound can be transmitted by it as long a distance as 200 or 300 miles.—*Liverpool Daily Post.*

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EDISONIA.

It is an undoubted fact that those connected with Mr. Edison believe he will overcome all difficulties mentioned by critics, and ultimately succeed in producing a cheap and simple electric lamp. Be that as it may, the history of the electric light is incomplete without the criticisms that have been urged against his system. The editors of the *Scientific American* handed a lamp to Dr. H. Morton, Dr. A. M. Mayer, and B. F. Thomas, M.A., for investigation, with the following result:—The first object, on receiving the lamp, was to determine roughly what amount and character of electric current would be needed to operate it efficiently. With this view a number of cells of a small Grove battery were set up, having each an active zinc surface of twenty square inches, and a platinum surface of eighteen square inches. The lamp being placed in the situation usually occupied by the standard burner in a Sugg photometer, the battery was, cell by cell, thrown into circuit. When ten cells had been introduced the horseshoe showed a dull red, with fifteen cells a bright red, with thirty-four cells the light of one candle was given, with forty cells the light of $4\frac{1}{2}$ candles, and with forty-five cells the light of $9\frac{1}{2}$ candles, and with forty-eight cells 16 candles. Having thus determined what amount of electric current would be required for experiments, arrangements were made to measure accurately the resistance of horseshoe while in actual use and emitting different amounts of light. The resistance of this carbon thread at the ordinary temperature had been already determined as 123 ohms in the usual way, but it was presumed, as had been shown by Matthiessen (*Phil. Mag.*, xvi., 1858, pp. 220, 221), that this resistance would diminish with rise of temperature.

To measure the resistance under these circumstances the apparatus was arranged as follows:—The current from the battery was divided into two branches, which traversed, in opposite directions, the two equal coils of a differential galvanometer. One branch then traversed the lamp, while the other passed through a set of adjustable resistances composed of German silver wires stretched in the free air of the laboratory, to avoid heating. Careful tests of these resistances showed that no sensible heating occurred under these circumstances. Matters being thus arranged, the resistances were adjusted until the galvanometer showed no deflection when the candle power of the lamp was taken repeatedly in the photometer, and the amount of resistance was noted. These measurements were several times repeated, shifting the coils of the galvanometer, and reversing the direction of the current. The results so obtained were as follows:—

Reistances.	Condition of Loop.
123 ohms.....	Cold.
94 ,, ...	Orange light.
83·7 ,, ...	$\frac{9}{10}$ candle.
79·8 ,, ...	5 ,,
75 ,, ...	18 ,,

The photometric measurement was in all these cases taken with the carbon loop at right angles to the axis of the photometer, which was, of course, much in favour of the electric lamp. On turning the lamp round so as to bring the carbon loop with its plane parallel with the axis of the photometer, *i.e.*, the edge of the loop turned toward the photometer disc, the light was greatly diminished, so that it was reduced to almost one-third of what it was with the loop sideways to the photometer disc. Having thus determined the resistance of the lamp when in actual use, it was next desirable to measure the quantity of the current flowing under the same conditions. To do this the current from fifty cells of battery was passed through a tangent galvanometer as a mere check or indicator of variations, and then through a copper voltameter, *i.e.*, a jar containing solution of cupric sulphates with copper electrodes immersed, and then through the lamp placed in the photometer.

Under these conditions it was found that during an hour the light gradually varied from about 16 candles at the beginning to about 14 candles at the end, making an average of about 15 candles, measured with side loop toward disc. The galvanometer during this time only showed a fall of half a degree in the deflection of the needle. Carefully drying and weighing the copper electrodes, it was found that one had lost 1·0624 grammes. Now, it is well known that a current of one weber takes up 0·00326 gramme of copper per second, which would make 1·1736 grammes in an hour; therefore the current in the present case must have been on the average $\frac{1{\cdot}0624}{1{\cdot}1736} = 0{\cdot}905$ webers, or a little less than one weber.

Having thus obtained the resistance of the lamp when emitting a light of 15 candles, namely, 76 ohms, and the amount of current passing under the same conditions—namely, 0·905 weber, we have all the experimental data required for the determination of the energy transformed or expended in the lamp expressed in foot-pounds. For this we multiply together the square of the current, the resistance, the constant 0·737335—which expresses the fraction of a foot-pound involved in a current of one weber traversing a resistance of one ohm for one second—and the number of seconds in a minute. Thus in the present case we have $0{\cdot}905^2 = 0{\cdot}8125$, and $0{\cdot}8125 \times 76 \times 0{\cdot}737335 \times 60 = 2753{\cdot}76$ foot-pounds. Dividing these foot-pounds per minute by the number of foot-pounds per minute in a horse-power, that is, 33,000, we have 0·08, that is, about eight one-hundredths or one-twelfth of a horse-power as the energy expended in each lamp. It would thus appear that with such lamps as this one horse-power of energy in the current would operate twelve lamps of the same resistance with an average candle power of 10 candles each,* or 120 candles in the aggregate.

Assuming that a Siemens or Brush machine were employed to generate the electric current, such a current would be obtained, as has been shown by numerous experiments, with a loss of about 40 per cent. of the mechanical energy applied to the driving pulley of the machine. To operate these twelve lamps, therefore, we should have to apply more than 1 horse-power to the pulley of the machine, so that when this loss in transformtion had been encountered there should be 1 horse-power of electric energy produced. This would call for $1\frac{2}{3}$ horse-power applied to the pulley of the dynamo-electric machine by the steam engine. To produce 1 horse-power in a steam engine of the best construction about 3lb. of coal per hour must be burned, and therefore for $1\frac{2}{3}$ horse-power 5lb. of coal must be burned. On the other hand, 1lb. of gas coal will produce 5 cubic feet of gas, and will leave besides a large part of its weight in coke, to say nothing of other "residuals," which will represent practically about the difference in value between "steam making" and "gas making coal," so that it will not be unfair to take 5lb. of gas coal as the equivalent of 5lb. of steam coal.

These 5lb. of gas coal will then yield 25 cubic feet of gas, which, if burned in five gas burners of the best construction, will give from 20 to 22 candles each, or 100 to 110 candles in the aggregate. We have, then, the twelve Edison lamps producing 120 candles and the five gas burners producing 100 to 110 candles, with an equivalent expenditure of fuel.

If each apparatus and system could be worked with equal facility and economy, this would of course show something in favour of the electric light; but when, in fact, everything in this regard is against the electric light, which demands vastly more machinery, and that of a more delicate kind, requires more skilful management, shows more liability to disarrangement and waste, and presents an utter lack of the storage capacity which secures such a vast efficiency, convenience, and economy in gas, then we see that this relatively trifling economy disappears or ceases to have any controlling importance in the practical relations of the subject.

(Additions and corrections to above.)

In reading the above article in print we notice some errors which require correction, and some points calling for a more full explanation. It is said that the *loss* of weight in one of the electrodes was 1·0624 grammes. This was, in fact, the amount *gained* by the cathode, the loss of the anode being a trifle greater. The gain of weight was, of course, what it was intended to take, so that the error was only in the expression, and not in the process or result. In the next place, in the foot note, it is simply stated that the average of the maximum and minimum lights in azimuths at right angles and in the plane of the loop was taken as the average luminous power of the lamp. Our reason for this, however, was not mentioned, but was, in fact, that we found by measuring the light at every azimuth varying by ten degrees between 0° and 180°, that this was approximately the true expression for the total amount of light emitted. We see from the article of Professors Rowland and Barker, in the *American Journal of Science*, that they, assuming certain conditions and discussing the same in a mathematical manner, have reached a different result; but as experiment shows this result not to be attained in fact, it is evident that the assumptions on which the mathematical reasoning is based do not include all the conditions present in the experiment.

Two other sets of experiments made since those given in our paper of April 17, in which the candle-power of the loop was in its best position, 17·6 and 19·8 candles, corresponding to averages of 11·7 and 13·2 candles respectively, showed a consumption of energy of 0·104 and 0·109 horse-power per lamp, or 9·6 and 9·1 lamps per horse-power. This would give 112 candles and 120 candles respectively per horse-power of electric energy consumed or transformed in the lamp. These results certainly

* The candle-power being 15 candles in the best position, and 5 candles at right angles to this, the average or general illuminating power of the lamp is 10 candles

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agree very closely with each other and with our former determinations.

Mr. W. C. Ramsdell writes on the above article to the Editor of the *Scientific American*:—"I have read to-day with much interest the results of Messrs. Morton, Mayer, and Thomas's experiments with an Edison electric lamp, published in the *Scientific American* of April 17. The results obtained, so far as they relate to the resistances of the loop while giving lights of different intensities and the current required for a light of fifteen candles, are valuable; but those given relative to the cost of one hundred and twenty candles are of *no* value, because it is (evidently) premised that the twelve lamps are to be in series in a single circuit, whereas in Mr Edison's proposed system each one of the twelve lamps would be placed in a branch circuit by itself, or, in other words, in multiple arc, and the cost would then be much less than the Stevens Institute experimenters report. The resistance of the armature of Mr. Edison's generator is so small that it may be neglected entirely without seriously affecting the value of calculations, and the resistances of the leading wires may also be made so small that their neglect will not make any appreciable difference. This being the case, let us see what would be the actual amount of coal required to maintain twelve electric lights in multiple arc, having a total intensity of one hundred and twenty candles.

"Before entering upon this calculation, however, let us determine the electromotive force required to supply a current of 0·905 weber, in a circuit of 76 ohms resistance. Multiplying the current by the resistance gives $0{\cdot}905 \times 76 = 68{\cdot}78$, which would be the required electromotive force in volts. Now, then, place the twelve lamps of 76 ohms resistance each in multiple arc, and their joint resistance will be one-twelfth part of that of a single lamp, or 6 1–3 ohms. As the current generated by the machine is to be divided among twelve branch circuits, so that each circuit will receive a current of 0·905 weber, it is obvious that the total current generated by the machine must be twelve times that required for a single circuit, or 10·860 webers. Multiplying the current by the resistance (as we did for the single lamp) gives $10{\cdot}860 \times 6\ 1\text{–}3 = 68{\cdot}78$, which is the required electromotive force, in volts, and is exactly the same as that required for a single lamp. Hence, even with a Brush or Siemens machine, where forty per cent. of the original energy is lost, the amount of coal required to operate twelve lamps giving an intensity of one hundred and twenty candles is only five twelfths of one pound, instead of five pounds, as calculated by the aforesaid experimenters.

"This shows a pretty large margin below the cost of producing a somewhat less light by coal gas, and in practice the margin would be still greater, for Mr. Edison's generator is said to transform considerably more than sixty per cent. of the original energy into effective current."

PHYSICAL SOCIETY.

APRIL 24.—Professor W. T. ADAMS in the chair. New Members: The Marquis of Blandford and Mr. J. Marshall.

Professor G. C. FOSTER read a note by Professor Rowland, of Baltimore, U.S., on the discovery of Mr. Hall—that a magnet exercises an electromotive on a current in a conductor crossing its field as well as a force on the conductor itself. This fact will render it necessary to apply a correction to equations which assume that only the latter force acts. The electromotive force in question is at right angles to the direction of the current and to the lines of magnetic force. Professor Baltimore expresses it mathematically in this note, and bases a new method of determining the value of v, the ratio of the electrostatic to the electromagnetic unit of electricity, which gives v almost identical with the velocity of light, thus confirming Clerk-Maxwell's theory of the nature of light. Dr. I. Hopkinson, F.R.S., suggested an expression for one of Professor Rowland's results.

Professor FOSTER also read a note by Professor Wild, of the Central Russian Meteorological Observatory, on a mode of correcting the bifilar magnetometer for torsion of its fibres, &c., and a method for finding the horizontal component of the earthy magnetism by its aid.

Mr. RIDOUT, F.C.S., described an improved thermo-electric apparatus of his construction. The author has followed the idea of combining the thermo-pile and galvanometer in one instrument on the same base-board. The defects of the apparatus as ordinarily made are a too great disparity between the resistance in the pile and in the galvanometer; the junctions of the pile are too deep, and short circuit the current; the bars too long and resisting, as well as too numerous; the junctions too slender; the mass of matter to be heated too great. These defects are remedied by placing the bars in glass tubes connected with thin plates of copper; making the bars half the usual length, and using only a single pair. The defects in the galvanometer are that the wire does not come near the needle; the needles are not of the best form, and the suspension is troublesome. Mr. Ridout makes the wire a flat ribbon mounted on one bobbin, the needles are flat oblong plates from the same piece of steel, and magnetised in one piece; they are mounted on a pivot turning in an agate cup. The several parts of the apparatus are mutually adapted to each other, and in using it the galvanometer is not joined to the pile till the latter has been exposed to the heat, so as to prevent the current generated abstracting heat from the hot side. As made by Mr. Browning, the pile consists of a pair of elements $\frac{1}{2}$in. long, the copper connections being circular plates $\frac{1}{100}$in. thick, and $\frac{5}{8}$in. diameter. The pile is supported by thick copper terminals above the galvanometer, which consists of a copper ribbon making some 20 turns round a pair of astatic needles 1in. long and $\frac{1}{4}$in. broad, pivoted in an agate cup, a contact key placed on one side, and the whole is enclosed in a glass shade perforated opposite the pile. A glass cone protects the front from extraneous heat, and a glass case the back. A directing magnet is fixed above the pile. Contact between the galvanometer and pile is made after (say) 30sec. exposure to the heat. The pile is affected by a person standing six feet from it, and the radiation from stellar space is evident in clear weather. Half a minute is sufficient to put the instrument ready for use.

Mr. RIDOUT also exhibited laboratory experiments showing cohesion in mercury by causing it to overflow up an inclined trough; electrolyses of water by a single Grove or bichromate cell through diminishing the pressure in the flask containing the water by boiling it and condensing the vapour on cooling; a differential thermometer showing absorption of heat on liquifying solids; and the production of musical notes in glass tubes by contracting the bore smoothly to about $\frac{1}{4}$ of the diameter at one part. Professor Forster remarked that the cohesion experiment might show the surface tension. Professor Guthrie and Professor Hughes offered remarks on the electrolytic experiment, the latter stating that he finds the resistance of an iron cell he has constructed to depend on the electrodes rather than the liquid; when the negative plate is tempered iron the resistance is low; when soft iron it is high.

Professor STONE exhibited photographs of König's new tonometer described by him at the last meeting, and further mentioned that König had devised a thermometer based on the principle that changes of temperature produce corresponding changes in the vibration rate of a tuning fork. The temperature is found from the rate of the fork by bringing it to a zero rate by means of a rider.

Professor MICHIN then described his experiments to solve the problem of transmitting light by photo-electric action. Two years ago he conceived the idea of employing for this purpose the fact that light falling on a sensitised silver plate disengages electricity. He forms a sensitive cell composed of two silver plates immersed in a conducting solution; one plate is coated with a sensitive emulsion of chloride or bromide of silver. When chloride is used a solution of salt in water forms the liquid, when bromide a solution of bromide of potash. A current is set up in this cell, even in the dark, but when exposed to the magnesium light, the current is very powerful, and flows within the cell from the uncoated to the sensitised plate. Professor Michin also conducted this current by wire to a second cell in a dark chamber, and found that it effected a decomposition of the sensitive plate in that cell, as shown by a distinct darkening of the plate when "developed" by pyrogallic acid. The same effect was produced whether the current was reversed or not. Professor Michin is continuing his experiments, and has provided a cable, containing a number of separate conductors, insulated from each other, in order to convey the currents from several cells.

Professor PERRY feared that the effect would not be strong enough; but Professor Michin said the light of a match produced a decided photo-electric effect in the cell. Professor Perry alluded to the selenium plan proposed by himself and Professor Ayrton, and said that Mr. Willoughly Smith had observed selenium to be sensitive to the shadow of a flying swallow. Professor ADAMS testified to the sensitiveness of selenium and its power of being directly excited by light, a fact first proved by the experiments of Mr. Day and himself.

THE GRAMME MACHINE.—M. Breguet contributes to the current number of the *Revue Industrielle* the first of a series of articles upon the theory of this machine.

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CITY AND GUILDS OF LONDON INSTITUTE.

Every man thinks himself perfectly familiar with the question of Education, and yet we should imagine that there really exists no other subject about which so much ignorance prevails. The first step towards understanding what a person who glibly talks about education means is to ask for his or her definition of education. The chances are that the speaker and hearer disagree at once upon this fundamental point. The popular idea is that a schoolmaster's duty consists in telling this and telling that, in fact to be constantly telling, whilst the scientific educationist argues that this system of telling is about the worst type of what education should be. Diverse as is the popular opinion upon the question of general education, it is still more so when "technical education" is the subject under consideration. We think it is time some one who really understands the whole subject should give a definition of what the advocates of "technical education" really mean. It is not enough to say the Germans, or the French, or the Americans have such and such a system, that these nations are beating us in the competitive markets of the world, because of the greater technical knowledge the artisans of these nations possess, and that we must, if we wish to hold our own, not only follow in their footsteps but beat them in their own special lines.

Dr. Johnson defines the word "technical" "belonging to the arts—not in common or popular use," though we are bound to admit that the definition to us is absolutely meaningless, and conveys no impression except that of uncertainty. If we descend from Dr. Johnson to the popular mind we find that "technical education" is frequently understood to mean the "knowledge of the proper way to use a tool," without any reference to the material, whilst a few include the proper use of the tool and the material in their definition. To us a good technical education includes a good general education, and is not something altogether apart from the ordinary educational curriculum. From this point of view the ideal technical education can only be obtained when it enters as part and parcel of common education. The idealistic school system, however, is utterly unworkable at the present time. Men are not ripe for it, and except to a few far-seeing and thoughtful minds it partakes somewhat of the nature of an Utopia. The innovator that would do most good is he who accepts things pretty much as they exist, and attempts nothing more than raising his voice for something but slightly removed from that conceived in the popular mind. He should, however, be always slightly above, and never be satisfied when the public mind reaches the point on the inclined plane upon which he but a moment since stood. It seems to us that the City and Guild Institute is working somewhat on these principles. The management accepts what is, and attempts to take technical education in hand and raise it slightly. Each step gained is of decided benefit. As education progresses, the ideal progresses, and seems as unattainable as ever; but no one because of this will say that education should stand still. In Professor Ayrton's report, he says, "By a technical school I understand not one in which the manipulation or routine of a trade is taught, but a school where a lad receives *general* instruction in the principles of applied science, and *special* instruction in the application of these principles to the particular trade he is following or about to follow." We are not quite sure whether Professor Ayrton goes as far as we should go. In our ideal system we include modern languages, such as French and German, as well as the mother tongue, and the course which Professor Ayrton sketches, when he says "As it is impossible at the present day to find boys fourteen years old, even at the best schools, knowing much or anything of science, the first year and a half of the course of *all* the students attending the technical school would be a *general* one, and would be devoted to the study of applied mathematics, applied physics, applied chemistry, &c.; the knowledge of the experimental sciences being obtained more by the students themselves working in the physical and chemical laboratories attached to the school than from lectures or bookwork. Lectures would be given, but such lectures should be rather for the purpose of guiding the students' minds in their laboratory work than to give them mere book knowledge; just as treatises of geography should, when feasible, be used rather as guide books than as means of dispensing with travelling. During the last year and a half of the boy's course the work would become more *special*, the student of telegraphy, for example, would now work specially in the telegraphic laboratory (which is not, of course, a place where simply telegraph instruments are made) and in the drawing-office, still, however, devoting some time to applied mathematics, experimental physics, and chemistry. The student of engineering, not constructing engines, but learning about the science of engines, and so on for the other trades."

The City and Guilds Institute undoubtedly accepts this general idea. Regular instruction has commenced. In connection with the Cowper-street Schools, pending the building of special laboratories, the professional lectures and tutorial supervision are carried on. Young men who in their every day work feel their deficiencies have an opportunity to increase their knowledge, youths preparing for the rough work of the world can receive special education as well as general education to better fit them for that work. On and

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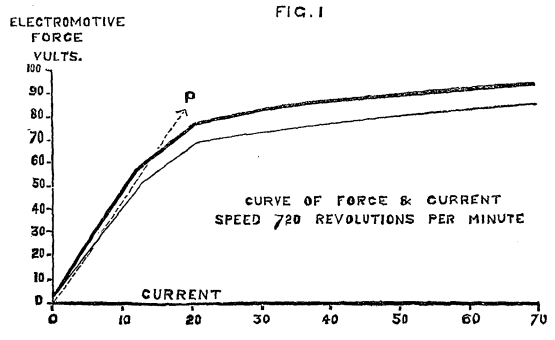
after May 10 day classes as well as evening classes will be established. The day classes will specially cater for the scientific requirement of persons partially engaged, or intending to engage, in the manufacturing industries. Amongst other things named we notice that Professor Ayrton is to give a special laboratory and tutorial course in electrical engineering. With such facilities in the way it seems important that employers should consider whether it would not be ultimately to their benefit to introduce some kind of half-time scheme amongst the apprentices. It is not to the young that we must look for consistent support. They cannot see the future, but the experience gained by older men shows that such education is of advantage, and it follows that they ought to persuade those who have no experience to follow a path that will to some extent, at any rate, facilitate excellence in future work.

ON ELECTRIC LIGHTING.*

BY DR. JOHN HOPKINSON, F.R.S., OF LONDON.

Dynamo-electric Machines.—Since the date of the author's former paper in April, 1879, other observers have published the results of experiments similar to those described by him. It may be well to exhibit some of these results reduced to the form he has adopted, viz., a curve, such as that shown in Fig. 4, *Proceedings* 1879, Plate 29, and now reproduced, with slight alterations, in Fig. 1. Here any abscissa represents a current passing through the dynamo-electric machine, and the corresponding ordinate represents the electromotive force of the machine for a certain speed of revolution, when that current is passing through it. It will be found (1) that with varying speed the ordinate, or electromotive force, corresponding to any abscissa or current, is proportional to the speed; (2) that the electromotive force does not increase indefinitely with increasing current, but that the curve approaches an asymptote; (3) that the earlier part of the curve is, roughly speaking, a straight line, until the current attains a certain value, and that at that point the electromotive force has reached about two-thirds of its maximum value. When the current is such that the electromotive force is not more than two-thirds of its maximum, a very small change in the resistance with speed of engine constant, or in the speed of the engine with resistance constant, causes a great change in the current. For this reason such a current, which is the same for all speeds of revolution, since the curves for different speeds differ only in the scale of ordinates, may be called the "critical current" of the machine. The effect of a change of speed is exhibited in Fig. 1,

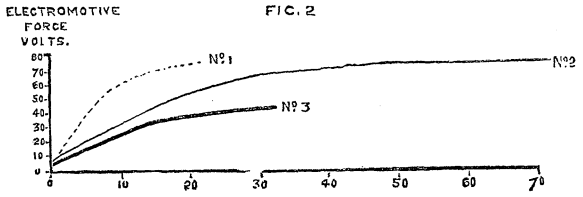
FIG. 1



where the lower line represents a curve for a speed of 660 revolutions per minute, instead of 720. The resistance, varying as $\frac{\text{electromotive force}}{\text{current}}$, is given by the slope of the line O P, which must therefore be constant; and it will be seen that this line cuts the upper curve at a point corresponding to a current of 15 webers, and the lower at a point corresponding to a current of 5 webers only.

In Germany, Auerbach and Meyer (Wiedemann's *Annalen*, Nov. 1879) have experimented fully on a Gramme machine at various speeds, and with various external resistances. The resistance of the machine was 0·97 ohms. Their results are summarised in a table at the end of their paper, which gives the current passing, with resistances in circuit from 1·75 to 200 Siemens units, and at speeds from 20 to 800 revolutions per minute. In the accompanying diagram, Fig. 2, curve No. I., in blue, expresses the relation between electromotive force and current, as deduced from some of their observations; the points marked are plotted from their table, making allowance, where necessary, for difference in speed. The curve, as actually constructed, is for a speed of 800 revolutions. At this speed it will be seen that the maximum electromotive is about

FIG. 2



76 volts; the critical current, corresponding to a force of about 51 volts, is 6·5 webers, with a total resistance of 7·8 ohms. Up to this point there will be great instability, exactly as was the case in the Siemens machine examined by the author, where the resistance was 4 ohms, and the speed 720 revolutions.

The results of an elaborate series of experiments on certain dynamo-electric machines have recently been presented to the Royal Society by Dr. Siemens. One of the machines examined was an ordinary medium-sized machine, substantially similar to that tried by the author in 1879. It is described as having twenty-four divisions of the commutator; 336 coils on the armature, with a resistance of 0·4014 Siemens units; and 512 coils on the magnets, with a resistance of 0·3065; making a total resistance of 0·7079 Siemens units = 0·6654 ohms. Curve No. II., in black, gives the relation of electromotive force and current reduced to a speed of 700 rev. per minute, the actual speeds ranging from 450 to 800 rev. The maximum electromotive force appears to be probably 76 volts, and the critical current 15 webers, which is the same as in the author's first experiments on a similar machine.

In the summer of 1879 the author examined a Siemens machine of the smallest size. This machine is generally sold as an exciter for their alternate current machine. It has an internal resistance of 0·74 ohms, of which 0·395 is in the armature or helix. The machine is marked to run at 1,130 rev. per min. The following table gives, for a speed of 1,000 rev., the total resistance, current, electromotive force, and horse-power developed as current. The horse-power expended was not determined.

EXPERIMENTS ON SMALLEST-SIZED SIEMENS DYNAMO-ELECTRIC MACHINE.

Resistance.	Electric Current.	Electromotive Force.	Horse-power developed as current.	Resistance.	Electric Current.	Electromotive Force.	Horse-power developed as current.
Ohms.	Webers.	Volts.	H.P.	Ohms.	Webers.	Volts.	H.P.
2·634	4·53	13·2	0·98	1·579	20·6	36·6	1·01
2·221	10·8	27·0	0·39	1·503	22·8	39·3	1·20
1·967	15·1	33·6	0·68	1·440	24·7	40·0	1·32
1·784	18·1	36·4	0·88	1·145	32·2	41·5	1·79
1·668	19·8	37·2	0·98				

Curve No. III., in red, gives as usual the relations of electromotive force and current. From this curve it will be seen that the critical current is 11·2 webers, and the maximum electromotive force, at the speed of 1,000 rev., is about 42 volts. The determinations for this machine were made in exactly the same manner as in the experiments on the medium-sized machine, using the galvanometer, but omitting the experiment with the calorimeter (compare Table I., page 249, *Proceedings*, April, 1879).

The time required to develop the current in a Gramme machine has been examined by Herwig (Wiedemann, June, 1879). He established the following facts for the machine he examined. A reversed current having an electromotive force of 0·9 Grove cells sufficed to destroy the residual magnetism of the electro-magnets. If the residual magnetism was as far as possible reduced it took a much longer time to get up the current than when the machine was in its usual state. A longer time was required to get up the current when the external resistance was great than when it was small. With ordinary resistance the current required from ¾ second to 1 second to attain its maximum.

Brightness of the Electric Arc.—The measurement of the light emitted by an electric arc presents certain peculiar difficulties. The light itself is of a different colour from that of a standard candle, in terms of which it is usual to express luminous intensities. The statement, without qualification, that a certain electric lamp and machine give a light of a specified number of candles, is therefore wanting in definite meaning. A red light

* Second Paper read at the Institution of Mechanical Engineers.

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cannot with propriety be said to be any particular multiple of a green light; nor can one light, which is a mixture of colours, be said with strictness to be a multiple of another, unless the proportions of the colours in the two cases are the same. Captain Abney (*Proceedings of the Royal Society*, March, 1878) has given the results of measurements of the red, blue, and actinic light of electric arcs, in terms of the red, blue, and actinic light of a standard candle. The fact that the electric light is a very different mixture of rays from the light of gas or of a candle, has long been known, but has been ignored in statements intended for practical purposes.

Again, the emission of rays from the heated carbons and arc is by no means the same in all directions. Determinations have been made in Paris of the intensity in different directions, in particular cases. If the measurement is made in a horizontal direction, a very small obliquity in the crater of the positive carbon will throw the light much more on one side than on the other, causing great discordance in the results obtained.

If the electric light be compared directly with a standard candle, a dark chamber of great length is needed—a convenience not always attainable. In the experiments made at the South Foreland by Dr. Tyndall and Mr. Douglas, an intermediate standard was employed; the electric light was measured in terms of a large oil lamp, and this latter was frequently compared with a standard candle.

Other engagements have prevented the author from fairly attacking these difficulties; but since May, 1879, he has had in occasional use a photometer with which powerful lights can be measured in moderate space. This photometer is shown in Fig. 3, and an enlargement of the field piece in Fig. 4. A lens, A,

FIG. 3.

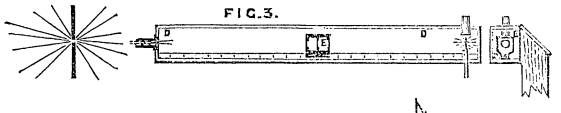
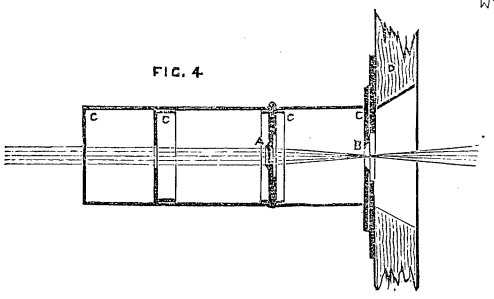


FIG. 4.



of short focus, forms an image at B of the powerful source of light which it is desired to examine. The intensity of the light from this image will be less than that of the actual source by a calculable amount; and when the distance of the lens from the light is suitable, the reduction is such that the reduced light becomes comparable with a candle or a carcel lamp. Diaphragms, CC, are arranged in the cell which contains the lens, to cut off stray light. One of these is placed at the focus of the lens, and has a small aperture. It is easy to see that this diaphragm will cut off all light entering from a direction other than that of the source; so effectually does it do so, that observations may be made in broad daylight on any source of light, if a dark screen be placed behind it. The long box, DD, Fig. 3, of about 7ft. length, is lined with velvet—the old-fashioned dull velvet—not that now sold with a finish, which reflects a great deal of the light incident at a certain angle. This box serves as a dark chamber, in which the intensity of the image formed by the lens is compared with a standard light, by means of an ordinary Bunsen's photometer, E, sliding on a graduated bar.

Mr. Dallmeyer kindly had the lens made for the author; he can therefore rely upon the accuracy of its curvature and thickness; it is plano-convex, the convex side being towards the source of light. The curvature is exactly 1 in. radius, and the thickness is 0·04 in.; it is made of Chance's hard crown glass, of which the refractive index for the D line in the spectrum is 1·517. The focal length f is therefore 1·933 inch.

Let u denote the distance of the source of light from the curved surface of the lens, and v the distance of the image of the source B from the posterior focal plane. Neglecting for the moment loss by reflection at the surface of the glass, the intensity of the source is reduced by the factor $\left(\frac{v}{u}\right)^2$. But $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$, or $v=\frac{uf}{u-f}$; hence the factor of reduction is $\left(\frac{f}{u-f}\right)^2$. The effect of absorption in so small a thickness of very pure glass may be neglected; but the reflection at the surfaces will cause a loss of 8·3 per cent., which must be allowed for. This percentage is calculated from Fresnel's formulæ, which are certainly accurate for glasses of moderate refrangibility, and for moderate angles of incidence.

Suppose, for example, it is required to measure a light of 8,000 candles; if it be placed at a distance of 40in., it will be reduced in the ratio 467 to 1, and becomes a conveniently measurable quantity. By transmitting through coloured glasses both the light from an electric lamp and that from the standard, a rough comparison may be made of the red or green in the electric light with the red or green in the standard.

A dispersive photometer, in which a lens is used in a somewhat similar manner, is described in Stevenson's "Lighthouse Illumination;" but in that case the lens is not used in combination with a Bunsen's photometer, nor with any standard light. Messrs. Ayrton and Perry described a dispersive photometer with a concave lens at the meeting of the Physical Society on 13th December, 1879 (*Proc. of the Physical Society*, vol. iii., p. 184). The convex lens possesses, however, an obvious advantage in having a real focus, at which a diaphragm to cut off stray light may be placed.

Efficiency of the Electric Arc.—To define the electrical condition of an electric arc two quantities must be stated—the current passing, and the difference of electric potential at the ends of the two carbons. Instead of either one of these, we may, if we please, state the ratio $\frac{\text{difference of potential}}{\text{current}}$, and call it the resistance of the arc, that is to say, the resistance which would replace the arc without changing the current. But such a use of the term electric resistance is unscientific; for Ohm's law, on which the definition of electric resistance rests, is quite untrue of the electric arc; and, on the other hand, for a given material of the electrodes, a given distance between them, and a given atmospheric pressure, the difference of potential on the two sides of the arc is approximately constant. The product of the difference of potential and the current is, of course, equal to the work developed in the arc; and this, divided by the work expended in driving the machine, may be considered as the efficiency of the whole combination. It is a very easy matter to measure these quantities. The difference of potential on the two sides of the arc may be measured by the method given by the author in his previous paper, by an electrometer, or in other ways. The current may be measured by an Obach's galvanometer, by a suitable electro-dynamometer, or best of all, in the author's opinion, by passing the whole current, on its way to the arc, through a very small known resistance, which may be regarded as a shunt for a galvanometer of very high resistance, or to the circuit of which a very high resistance has been added.

It appears that with the ordinary carbons and at ordinary atmospheric pressure no arc can exist with a less difference of potential than about 20 volts; and that in ordinary work, with an arc about $\frac{1}{4}$ in. long, the difference of potential is from 30 to 50 volts. Assuming the former result, about 20 volts, for the difference of potential, the use of the curve of electromotive forces may be illustrated by determining the lowest speed at which a given machine can run, and yet be capable of producing a short arc. Taking O as the origin of co-ordinates, Fig. 5, set off upon

FIG. 5.

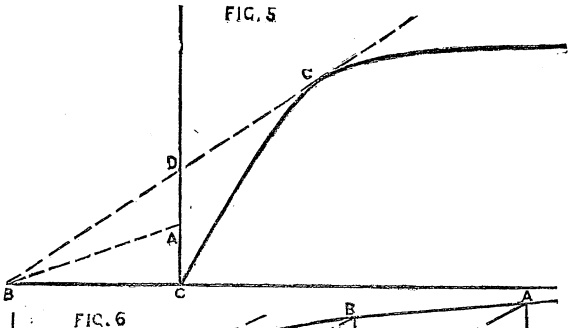
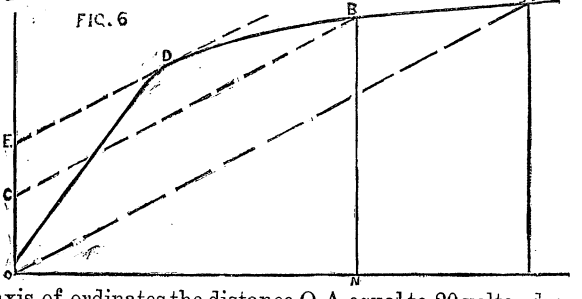


FIG. 6.



the axis of ordinates the distance O A equal to 20 volts; draw A B to intersect at B the negative prolongation of the axis of abscissæ, so that the ratio $\frac{O A}{O B}$ may represent the necessary metallic resistance of the circuit. Through the point B, thus obtained,

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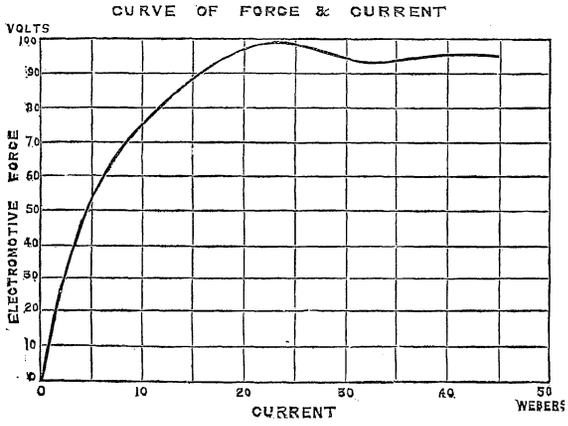
draw a tangent to the curve, touching it at C, and cutting O A in D. Then the speed of the machine, corresponding to the particular curve employed, must be diminished in the ratio $\frac{O D}{O A}$, in order that an exceedingly small arc may be just possible.

The curve may also be employed to put into a somewhat different form the explanation given by Dr. Siemens at the Royal Society, respecting the occasional instability of the electric light as produced by ordinary dynamo-electric machines. The operation of all ordinary regulators is to part the carbons when the current is greater than a certain amount, and to close them when it is less; initally the carbons are in contact. Through the origin O, Fig. 6, draw the straight line O A, inclined at the angle representing the resistances of the circuit other than the arc, and meeting the curve at A. The abscissa of the point A represents the current which will pass if the lamp be prevented from operating. Let O N represent the current to which the lamp is adjusted; then if the abscissa of A be greater than O N, the carbons will part. Through N draw the ordinate B N, meeting the curve in the point B; and parallel to O A draw a tangent E D, touching the curve at D. If the point B is to the right of D, or further from the origin, the arc will persist; but if B is to the left of D, or nearer to the origin, the carbons will go on parting, till the current suddenly fails and the light goes out. If B, although to the right of D, is very near to it, a very small reduction in the speed of the machine will suffice to extinguish the light. Dr. Siemens gives greater stability to the light by exciting the electro-magnets of the machine by a shunt circuit, instead of by the whole current.

The success of burning more than one regulating lamp in series depends on the use in the regulator of an electro-magnet, excited by a high-resistance wire connecting the two opposed carbons. The force of this magnet will depend upon the difference of potential in the arc, instead of depending, as in the ordinary lamp, upon the current passing. Such a shunt magnet has been employed in a variety of ways. The author has arranged it as an attachment to an ordinary regulator; the shunt magnet actuates a key, which short-circuits the magnet of the lamp when the carbons are too far parted, and so causes them to close.

In conclusion, the author ventures to remind engineers of the following rule for determining the efficiency of any system of electric lighting in which the electric arc is used, the arc being neither exceptionally long nor exceptionally short. Measure the difference of potential of the arc, and also the current passing through it in volts and webers respectively, then the product of these quantities divided by 746 is the horse-power developed in that arc. It is then known that the difference between the horse-power developed in the arc and the horse-power expended to drive the machine must be absolutely wasted, and has been expended in heating either the iron of the machine or the copper conducting wires.

Messrs. Crompton, Preece, and Shoolbred took part in the discussion upon this paper, which, however, unfortunately was commenced at a late hour, when many had left the room. Mr.



Shoolbred exhibited the above diagram, showing the results of experiments at Silvertown, carried out on the A Gramme machine by Mr. K. Gray.

THE EDISON ELECTRIC LIGHT.

In our issue of April we gave Professor Barker's contribution on this subject from Silliman's *American Journal of Science* a special proof of which had been sent to us from America for our readers. We now give Professor Marks's criticism on this article. Professor Marks contributed this letter to our contemporary, the *Engineering and Mining Journal*:—

"Sir: The recently published results of the experiments of Professors Rowland and Barker are the only reliable data with regard to the Edison light which have as yet been presented to the public; and while these results are undoubtedly mathematically correct, save the assumption, *wholly unwarranted by any quoted experiments*, that the power which reaches the lamp is to the power developed by the engine as 70 is to 100, they convey to the general reader a wrong impression of the practical working of the light as it now is.

"The professors have apparently overlooked the fact that distribution of light, rather than production of light, by means of electricity, is the end which must be attained by Mr. Edison before his light can be deemed a practical success.

"The economy of the production of light by electricity will be found to be greatly increased as the intensity of the light produced at any one point is increased; and the experiments made show that, with a light suitable to replace an ordinary gas-jet, and without making any allowance whatever for losses in the engine, electric machine, or wires, about 7½ five-foot gas-jets can be replaced by one horse-power in the form of electricity.

"Taking Professor Rowland's assumption of 70 per cent. of the electric light per horse-power in electricity is equal to the light per indicated horse-power at the engine, we have 5¼ lights per indicated horse-power.

"The writer is inclined to believe that about five lights per horse-power per hour is in excess of what Mr. Edison is now doing, as he was informed by Edison's engineer that the engine, when developing about 21 horse-power, ran about 90 lights, which burned very much in the same manner as a similar number of gas-jets. We see that each horse-power corresponded to about 4·3 lights of the apparent brilliancy of ordinary gas-jets, which hardly ever consume as much as five feet of gas per hour.

"The average cost of one horse-power per hour, when fuel, attention, lubrication, and wear and tear on belts, shafting, &c., are considered is about 4 cents per hour. This cost is the actual result in some of the best works about Philadelphia.

"The comparative cost of electricity and gas can now be computed:—

"For 7½ lights per horse-power per hour, illuminating gas costs $1·07 per 1,000.

"For 5¼ lights per horse-power per hour, illuminating gas costs $1·52 per 1,000.

"For 4·3 lights per horse-power per hour, illuminating gas costs $1·86 per 1,000.

"The method of computation is very simple: 7½ lights, if replaced by gas, would require 7½ × 5 cubic feet of gas = 37½ cubic feet. Then we have, by the Rule of Three,

37½ : 1,000 :: 4 : 107.

"In admitting that Edison has produced 7½ *separate* lights of say 17 candle-power per indicated horse-power, we give him better results than he himself can claim.

"Now, it is easy to see that if the gas companies are producing gas and getting it into the holder for less than the best figures given ($1.07), it will be impossible to supersede gas by electricity until further advances have been made in the reduction of its cost, allowing that the electric plant will cost no more than the plant of an ordinary illuminating gas company.

"All those familiar with the manufacture of gas know that it is produced at a cost far below $1.07 per thousand.

"The writer has no desire to depreciate Mr. Edison's work, and heartily wishes him a rapid and successful result from his labours; but it is wrong as well as ridiculous to endeavour to create a sensation by misconstruing the results of Professor Rowland's measurements, and by dabbling in statements as to comparative cost of electricity and illuminating gas without actually knowing either. "WILLIAM D. MARKS,

"University of Pennsylvania, April 18. Prof. Dyn. Eng."

ON SOME OF THE EFFECTS PRODUCED BY AN INDUCTION COIL WITH A DE MERITENS MAGNETO-MACHINE.*

BY WILLIAM SPOTTISWOODE, P.R.S.

In the *Philosophical Magazine* for November of last year I gave an account of a mode of exciting an induction coil by the direct application of one of M. de Meritens' alternating machines, without the intervention of a contact-breaker or the use of a condenser. The experiments of Professor Dewar on the arc furnished by the machine itself on its spectrum, and on its behaviour in respect of electrolysis, described before the Royal

* Abstract of a paper presented to the Royal Society in February, 1880.

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Society (see "Proceedings," Feb. 13, 1880), have led me to think that an account of some of the peculiarities in the induced discharge, to which the machine gives rise, might be acceptable to the Society.

And, first, as regards the secondary discharge in air. It was mentioned in the paper first quoted that the spark produced by this machine presented an usually thick yellow flame, and that it was accompanied by a hissing noise different from that commonly heard with a coil excited by a battery. As the machine gives alternate currents, the secondary discharge presents sparks of equal strength in both directions, and the general appearance to the eye is symmetrical in respect of both terminals. The spark was observed in a revolving mirror, first in a vertical and secondly in a horizontal direction. The discharge, although apparently continuous, was immediately seen to be intermittent, with a period in unison with that of the machine. Tongues of flame, leading alternately from one terminal and from the other, crossed the field of view. The length of spark first used (vertically) was about half an inch. When the length was increased to about two inches, flashes or bands of continuous light were seen to traverse the field of view in diagonals of low slope (*i.e.*, nearly horizontally), showing that there were masses of heated matter passing from time to time to moderate velocity between the terminals. From the known period of the machine, and the number of the discharges crossed by these flashes in their passage from terminal to terminal, it was calculated that the time of passage was about ·03 of a second. Occasionally there was a still brighter flash or meteor, which similarly traversed the field, but with a velocity apparently of about double that of the others.

When the discharge was set horizontally similar phenomena were seen, but at a distance about midway between the two terminals the flames appeared to meet, and at their point of meeting they showed continuous luminosity throughout. When the flame was blown aside there appeared occasionally and at rather long intervals the true spark, evinced by an irregular bright line reaching from one terminal to the other.

On observing the discharge in air attentively it was noticed that whenever a true spark passed its passage was marked, as usual, by an irregular bright line when its path was outside the aureola or flame; but by a similar dark line when its path was within the aureola. Whether this be a merely subjective effect due to the fatigue of the nerves of the retina by the bright spark which always precedes the aureola in point of time, or whether it has any electrical significance, perhaps requires further examination.

The spectrum of the secondary spark was then examined with terminals of various metals.

Aluminium.—The spectrum showed a faint continuous background with the yellow sodium lines, and faint oxide of aluminium lines. This was with a spark of half an inch. But although the spark was subsequently lengthened, no difference in the spectrum was perceived excepting that the continuous background was rendered more bright.

It would seem that these appearances are due to some such process as the following:—The heat due to oxidation, added to that of the discharge, is sufficient to volatilise the oxide of aluminium; but that in its passage across the interval between the terminals, the oxide becomes so cooled that it gives a continuous spectrum. When the spark was lengthened, the oxide, although perhaps at first more heated than with the shorter spark, had more time to cool.

Magnesium.—In this, as in the former case, we have a faint continuous spectrum as a background, on which were seen the *b* group of magnesium lines. One other line in the blue occasionally flashed out, but was not permanently present. There was also a faint trace of the oxide spectrum. The contrast between the cases of aluminium and magnesium, in respect of the prominence of the oxide, or of the true metallic spectrum, is doubtless due to the fact that in the former case the oxide, and in the latter the metal, is the one which is more easily vaporised. On sending a blast of air on the discharge, the blue line always disappeared; the current of air having lowered the temperature so far as to prevent the vaporisation necessary for its production.

When the spark between magnesium terminals was made to pass through hydrogen, the characteristic lines of hydrogen were seen, apparently owing to a rise in temperature. This, as mentioned below, does not occur with carbon poles.

Platinum.—With terminals of this metal the spectrum was mainly continuous, with the addition of the ubiquitous yellow sodium lines. When the spark was short a few bands were faintly visible, some apparently those of nitrogen, and others in the blue and violet belonging to the oxide of platinum. When the spark was lengthened, these bands disappeared, and nothing but the continuous spectrum (with the D lines) was visible.

It appears from these experiments that the application of the de Meritens machine to the induction coil furnishes us with the means of isolating certain lines of the metallic spectrum from the rest. It has, in fact, enabled us to reduce at pleasure the spectra of aluminium, of magnesium, and of platinum, to their most persistent lines; precisely as had already been noticed as occurring by natural processes in the cases of sodium and of calcium. As a general rule, when the spark is shortened, the metallic, or the oxide, lines come out, when it is lengthened they disappear.

From this we may conclude (1) that the discharge which we have been examining, is a real flame with metallic particles passing between the terminals in a solid condition; and (2) that in general the temperature is comparatively low—*i.e.*, that it is insufficient to cause any considerable vaporisation. This is notably the case when the arc is long, and when the matter thrown off from the terminals has sufficient time in its passage to cool.

The spark was then tried between carbon terminals in atmospheres of hydrogen and of carbonic acid. In none of them did the spectrum show any gas lines; but with hydrogen there were faint traces of the hydrocarbon group in the green. In this respect the spark differs from the discharge direct from the machine, inasmuch as the latter gives some of the hydrogen lines in hydrogen and carbon lines in carbonic acid.

When the spark was discharged in a magnetic field, known phenomena were reproduced, but owing to the thickness and mass of the flame and the extraordinary strength of the magnetic field, they were exhibited in a state of great splendour.*

When the spark passed in an equatorial direction the whole flame was spread out in an equatorial plane, in which heated masses might be seen revolving in one direction or in the other in the neighbourhood of each of the magnetic poles. To give some idea of the actual appearance, it may be mentioned, that a symmetrical spindle-shaped discharge, 15 millims. in length and 3 millims. in thickness, was spread out by the magnet into a disc of about 15 millims. in diameter and 1 millim. in thickness. When the spark passed in an axial direction, or when the poles themselves were made the terminals, the phenomena described in my paper "On an Experiment in Electro-Magnetic Rotation" ("Proc. Roy. Soc.," March 30, 1876) were reproduced.

Whatever was the direction of the spark the resistance due to the magnetic field was such as to extinguish the discharge, provided that the striking distance was near the limit that it could attain when no magnetic field was present. If a plate of glass was interposed between the poles of the magnet (which were still used as terminals) the yellow flame disappeared, and the spark divided itself into numerous ramifications of true sparks, which found their way round the edges of the plate. As soon as the magnet was excited the resistance in the field became so great as to exceed that of the glass plate itself, and the plate was pierced.

When magnesium terminals were used in an atmosphere of hydrogen, the yellow sodium lines, the blue and green magnesium lines, and the red line of hydrogen were visible near the terminals, with a continous background. When the magnet was excited, the only change observed was that the lines became slightly fainter.†

Professor Dewar was good enough to measure the efficiency of the secondary discharge, by taking an inch spark in a glass bulb placed in the centre of a calorimeter, in the same way as he had already measured the efficiency of the intermittent current direct from the machine. The former amounted to about 430 gramme-units per minute, while the latter had been found to be 6,000 per minute. The relative efficiency may, therefore, be taken at about 1 : 15. And as the machine was giving about 300 currents per second, this would give for the secondary

$$430 : 60 \times 300 = \cdot 023 \text{ units per discharge,}$$

and for the primary

$$6{,}000 : 60 \times 300 = \cdot 3 \text{ units per discharge.}$$

The results in the case of the secondary discharge may not perhaps possess any great degree of accuracy; but, in the absence of any other information on the question, they may serve to indicate the general scale of magnitude by which the coil discharge is related to that of the machine.

Leaving the subject of the spark from the induction coil, one of the most remarkable effects produced by this machine was the illumination of vacuum tubes by the currents taken simply from the machine. A small sphere of about two inches in diameter, with an air-vacuum, and having two parallel straight terminals reaching nearly across the sphere and about half an inch apart, was (after the first attempt, when there was some

* Through the kindness of the authorities of the Royal Institution, Faraday's great electro-magnet, excited by the Siemens machine, was placed at my disposal.

† There was some reason to think that, at the moment of making the magnet current, the lines became decidedly brighter, and that they lost their brilliancy if that current was maintained. But this, perhaps, requires further examination.

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difficulty in getting the discharge to pass) readily illuminated. Owing to the alternate currents, both terminals were of course surrounded with the usual blue halo. When the speed of the machine was reduced, the discharge through the tube was not maintained, showing that only only that part of the current from the machine which possessed the highest electromotive force, and perhaps also the greatest strength, was sufficient and was therefore actually used for the purpose. As this was apparently only a small fraction of the whole current, we may herein find an explanation of the fact that, compared with the effect from the induction spark, the illumination was moderate, and the heating insignificant. It would perhaps not be easy to establish an accurate comparison between this and other sources of electricity; but some idea may be conveyed by the fact that, from experiments made with this tube with Mr. De La Rue's chloride of silver battery on a former occasion, and quite independently of the present question, it was estimated that a current having an electromotive force of 400 volts was necessary to effect a discharge.

Other tubes were tried, and were illuminated in the same way.

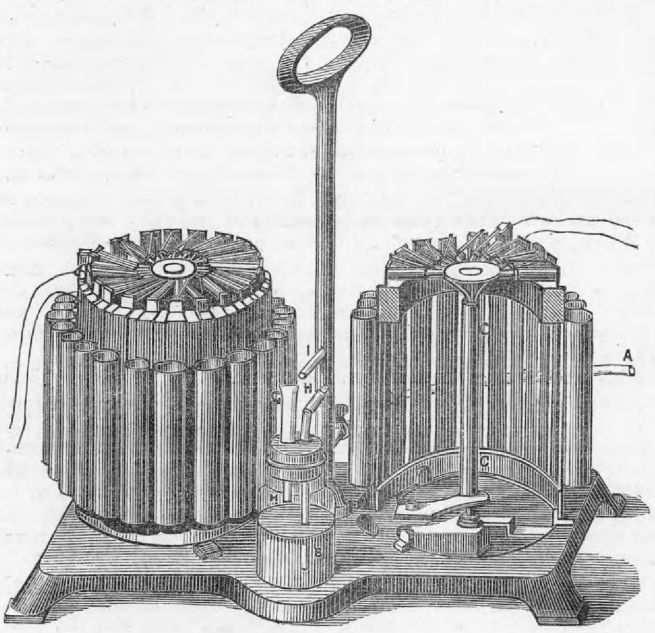
When the tube was placed in the magnetic field, the discharge underwent the modifications described by Plücker, by Hittorf, and by others. But it may be mentioned as a result of the extraordinary strength of the field here employed that, whenever the tube was so placed that the direction of discharge made any considerable angle with the lines of magnetic force passing through it, the discharge was completely extinguished. When the tube was removed to a weaker part of the field, the discharge reappeared distorted in form, and altered in colour in a manner known to those who have experimented in this direction.

THERMO-ELECTRIC BATTERY OF M. NOË.

BY M. A. NIAUDET.

(Translated from *La Nature*.)

This battery is frequently used and is much appreciated in Austria and Germany. It is made of different forms, of which the most recent, represented by Fig. 1, appears to us to be the



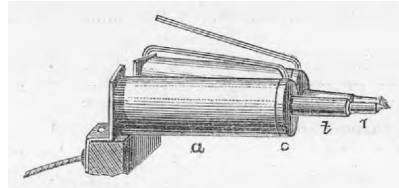
best, since it requires only two Bunsen burners to set in action forty thermo-electric elements. There is another model, of sixty elements, with three burners, which offers the same advantages as the one represented.

Each circular group of twenty elements should be separately considered. The following is the description of such a group:—

The elements are arranged in a horizontal plane, and radially; the heated junctions being towards the centre of the circle, and the cooled junctions at its circumference.

The two metals are: 1st. German silver (called *maillechort* in France and *neu Silber* in Germany), and, 2ndly, an alloy of antimony and zinc which fuses at a temperature slightly higher than the melting point of antimony.

These two metals are soldered (at least at the heated junction) without the intermediary of any other metal; the ends of the German silver wires pass into a little capsule of brass, which forms the bottom of the mould in which the other metal is cast. This capsule is shown at *c* in Fig. 2, which represents two elements of the actual dimensions; it remains attached to the element and forms part of the apparatus.



Into the same capsule penetrates a small rod, *r*, of copper, the extremity of which is also enveloped by the cast metal; and by means of this rod the heat is conducted to the heated junction. The extremities of these copper rods are arranged in a small circle and are held between two circular plates of mica, so that they all become heated by the same flame. In the apparatus shown, a Bunsen burner is adopted; but in some simpler apparatus the flame of a spirit (wood naptha) lamp is used. The mica plate has the effect of concentrating and directing the heat of the flame on to the copper rods.

The object of using the copper rods at the heated junction will be seen from the following:—The heated junction does not obtain its heat directly from the flame, but only through the intermediary of the copper rod; it is therefore protected against any accident through overheating, *i.e.*, against the fusion of the alloy, which would cause the immediate break down of the battery.

To avoid, at least partially, the loss of heat by radiation, these copper rods are enclosed, excepting at their extremeties, within a small tube, shown at *t* in Fig. 2.

The cooled junction is altogether dissimilar; the fusible metal is here soldered to a plate of copper, to which is soldered the German silver wire of the next element. The plate of copper is of large surface, forming a cylinder through which the air circulates, with the production of a cooling effect.

These batteries have been subjected to careful experimental trial by M. Waltenhofen, of Prague; he has compared them with that of Marcus, and has found them to be much superior to it.

It was found in the previous experiments of M. Stefan, of Vienna, that the thermo-electric elements of Marcus may obtain an electromotive force of $\frac{1}{18}$ volt, but this maximum is obtained only at a temperature close upon the fusing point of one of the alloys of which they are formed.

Under similar conditions, M. Waltenhofen found that the Noë elements possess an electromotive force between $\frac{1}{9}$ and $\frac{1}{10}$ volt.

In practice, these maxima, or anything near them, cannot be depended upon, and, when several elements are connected in series, they are never attained, because the elements are never equally heated. For ordinary experiments we may calculate upon $\frac{1}{16}$ volt per element. The resistance of each element is $\frac{1}{40}$ Siemens' unit.

An improvement which is supplementary, but very useful in practice, consists of the addition of a regulator of the pressure of gas, by means of which any overheating, and the accidents which ensue from it, are avoided. It formerly sometimes happened that an unexpected increase in the gas pressure produced some fusion of the metal, and thus deteriorated the battery.

The safety apparatus here referred to, and which is shown in the front part of Fig. 1, consists of a glass bottle containing water, and closed by a cork. Two tubes enter this bottle through the cork; one, B B, is a branch from the gas supply, and passes to the bottom of the vessel; the other, H, does not reach the surface of the water. Its use is to lead away any gas passing into the bottle, and to conduct it to the small gas jet, I, which is kept constantly lighted. If the pressure of gas be low, the tube B is closed by the water; if it should become too great, the gas bubbles through the water and escapes at G, where it inflames. The apparatus thus constitutes a safety-valve, preventing the pressure from rising above a certain degree, which can be regulated at will. The gas which escapes, being at once consumed, cannot give rise to accident.

With a battery of 12 elements, it is possible to work an electric bell; with twenty elements, water may be decomposed in the voltameter; with forty elements, a secondary battery of Planté may be charged, or an induction coil worked. In a word, these batteries allow of most of the experiments in physics, and small industrial operations, gilding, plating, nickelling, &c., being carried into effect.

One great advantage of this kind of electro-motor is that it is set in full action in one or two minutes, and all expenditure ceases the moment the current is no longer required.

Lastly, and this is the most important point, the battery undergoes no alteration by use, as in the case of those which have preceded it, and which in a short time show a considerable internal resistance, and a corresponding diminution of effect.

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TELEGRAPH SHARE LIST.

Companies.	Closing Prices May 5.		Business Done Week Ending May 5. Highest.		Lowest.	
Anglo-American Ordinary	61,	½	61⅝		60½	
Do. "B"	90¼,	½	90⅝		90	
Do. "A"	34¼,	¾	34¾		33½	
Brazilian	7⅝,	8	8		7⅞	
Cuba	9¾,	10¼	—		—	
Do. Ten per Cent. Pref.	16½,	⅝	—		—	
Direct Spanish	1¾,	2¼	—		—	
Do. Ten per Cent. Preference	10¾,	11¼	11		11	
Direct United States x d April 29	11¼,	½	11½		11⅛	
Eastern	8 13-16,	15-16	9		8 13-16	
Do. Six per Cent. Debenture	102,	4	—		—	
Do. Five per Cent. do.	102,	4	103		103	
Do. Six p Ct. Preference	12⅛,	⅜	12⅛		12¼	
Eastern Extension x d April 29	8⅞,	9	9 1-16		8 13-16	
Do. Six per Cent. Deb.	106,	9	—		—	
German Union	8¾,	9¼	9⅛		8⅞	
Globe Telegraph & Trust	5 15-16,	6 1-16	6⅛		5 15-16	
Do. Six p Ct. Preference	11⅝,	¾	11⅞		11¾	
Great Northern x d April 29	9¾,	10	10		7⅞	
Indo-European	24,	5	—		—	
Mediterranean Extension	3,	⅛	—		—	
Do. Eight per Cent. Preference	10½,	11½	—		—	
Reuter's	10,	11	—		—	
Submarine	232,	38	—		—	
West India and Panama	1 13-16,	15-16	2		1⅞	
Do. Six per Cent. Preference	8,	¼	8⅛		8⅛	
Western and Brazilian	8,	¼	8 7-16		8⅛	
West. Union 7 p. Ct. 1st Mt. x d May 3	117,	22	—		—	
Do. Six per Ct. Sterg.	102,	4	—		—	

TRAFFIC RECEIPTS FOR APRIL, 1880.

Companies.	April 1880.	April 1879.	Incrse.	Decrse.
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	3,100 estd.	3,140	—	40
Direct Spanish Telegraph Company	—	—	—	—
Direct United States Telegraph Company	—	—	—	—
Eastern Telegraph Company	44,748	37,846	6,902	—
Eastern Extension Telegraph Company	24,342	21,060	3,282	—
Great Northern Telegraph Company	18,360	—	—	—
Submarine Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—
West India and Panama Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—

ADDRESSES.

MARSHALL, SONS, and Co., Limited, Britannia Works, GAINSBOROUGH, and 3, KING-STREET, CHEAPSIDE.
Specialities—Portable and Fixed Engines specially adapted for Driving Electric Light Machinery.

PETER BROTHERHOOD, Engineer, 56 and 53, COMPTON-STREET, GOSWELL-ROAD, E.C.
Specialities—Patent 3-Cylinder Engines (Silver Medal, Paris), as used by Siemens, Gramme, and Wilde for driving Electric Machines.

RANSOMES, SIMS, and HEAD, Orwell Works, IPSWICH.
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TABLE OF THE TOTAL ADDITIONS MADE UP TO DECEMBER 31, 1874, TO POLICIES OF £1,000 EACH.

Ages at Entry.	NUMBER OF PREMIUMS PAID. Thirty.	Twenty-five	Twenty.	Fifteen.	Ten.	Five.
30	£685 10 0	£549 0 0	£434 10 0	£290 10 0	£175 0 0	£78 10 0
45	841 0 0	678 10 0	533 0 0	353 10 0	211 0 0	93 0 0
60	——	——	787 10 0	517 0 0	310 10 0	137 10 0

G. W. BERRIDGE, *Actuary and Secretary.*

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SLIP

THE MANILLA-HONG-KONG CABLE.—We understand this new cable is working satisfactorily.

THE FULLER ELECTRIC LIGHT.—This system has been adopted at the Greenwood rolling mill, Pa., U.S.A.

JAMIN'S ELECTRIC LIGHT.—A company has been formed to work this light, with a capital of 8,000,000 francs.

NEW CABLE.—The King of Spain has signed a decree authorising a new cable to be laid between Cuba and Jamaica.

LONDON PLATINO BRAZILIAN TELEGRAPH COMPANY.—A dividend of 2s. 6d. per share is announced, payable after the 25th inst.

HIDDEN TREASURE REVEALED BY LIGHTNING. — At Fenerstenwalde, near Berlin, a stroke of lightning recently exposed a hidden treasure consisting of gold and silver bars.

THE ELECTRO-TECHNICAL SOCIETY at Berlin now numbers 1,248 members. Professor Zetsche, the secretary, is the right man in the right place, and the society is benefiting by his efforts.

SIR WILLIAM THOMSON presided at the meeting of the Physical Society (of which he is President) on Saturday last. An account of this interesting meeting will be found on another page.

AN ELECTRICAL TONE-RECORDER.—MM. Leclerc and Vincent have described to the Physical Society of Paris an electrical instrument which will automatically record the notes played upon a piano of any construction.

TOO GOOD TO BE TRUE.—It is said that a M. Parodie claims to have discovered a method of transmitting large quantities of electricity over long distances, distributing it at any number of points as required on the way.

DR. SIEMENS was prevented by illness from describing his experiments on the use of the electric light in horticulture and metallurgy to the Society of Telegraph Engineers last Wednesday. We are glad to say that he is better.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts for the month of April, 1880, amounted to £18,360. Total traffic receipts 1st January to April 30, £66,240; corresponding months of 1879, £57,610; corresponding months of 1878, £61,430.

PROFESSOR FLEEMING JENKIN, F.R.S.—The Royal Society of Edinburgh has awarded the Keith Medal for the biennial period 1877-79 to the well-known electrician Professor Jenkin, for his paper on the application of graphic methods to the determination of the efficiency of machinery.

THE TELEPHONE AT CHESTER.—The telephone is being gradually introduced by business houses in lieu of messengers from office to workshop. In Chester Messrs. J. Dickson and Sons have established telephonic communication between their chief office in Eastgate, and their nurseries at Newton.

EASTERN AND EASTERN EXTENSION TELEGRAPH COMPANIES.—The traffic continues to steadily advance, and for April the increase of the Eastern amounts to near £7,000. The Extension Company also shows an increase of receipts amounting to nearly £3,300. Part of the increase in the case of the Eastern Company is due to the Cape cable.

A RIVAL.—Our contemporary, *Gas and Water Engineering*, writes, "The doctors are after the electric light. They say it will eventually destroy the eyesight, and one medical man says he was blind for three days, the result of attending a concert in San Francisco in a hall supplied with the electric light. Edison has given us this eye destroyer; now let him give us invulnerable eyes."

ALTERATION OF RATE TO JAPAN.—The Japanese administration announces that from the 1st July next their terminal rate for Nagasaki messages will be the same as for all other stations in Japan. The rate for messages by the Northern Company's lines from this country to Nagasaki (hitherto 8s. 4d. per word) will therefore from that date be 9s. 3d., the same as to all other stations in Japan.

WEST INDIA AND PANAMA TELEGRAPH.—The receipts for the half year ended December 31 were £35,630, and the expenses £22,475, the net balance, including a small surplus brought forward, being £14,787. Of that sum £2,000 has been carried to the reserve fund, and, after providing for the interest on the first and second preference shares, a balance of £1,017 remains to be carried forward.

GREAT NORTHERN TELEGRAPH COMPANY.—TELEGRAMS TO JAPAN.—The Japanese Telegraph Administration announces that henceforth a charge of ten dollars per annum will be made for all abbreviated addresses of receivers of messages registered in Japan. The addresses now registered will remain in force until the 1st September, this year, when they will be cancelled, if the above fee of ten dollars is not paid.

THE ELECTRIC LIGHT AT THE LIZARD.—The crew of the schooner Conovium, of Aberystwith, bound from London for Dublin, with cement, landed at Penzance on Wednesday morning, their vessel having struck on the Stag Rock, near the Lizard, on Tuesday night, and foundered. The captain attributed the disaster to the glare of the electric light at the Lizard, which made him believe that he was at a greater distance from the land than he actually was.

CONGRESS.—The Congressional Committee on the Revision of Laws reported favourably, on the 27th ult., the bill introduced some weeks since, which provides that all telegraph messages shall be deemed to be private papers of the senders and receivers of the same, and shall be protected from unreasonable search and seizure, and from production in judicial and legislative proceedings to the same extent as communications sent by the United States mail.

ST. LOUIS.—The electric light promises to be largely adopted in St. Louis by private parties. The Merchants' Exchange will soon be lighted by electricity, displacing a thousand or so gas jets. C. Conrad and Co., on Sixth-street, have three excellent lamps; Samuel C. Davis and Co., on Washington-avenue, have their immense establishment lighted up by the Brush machine, and there are a number of others talking of putting the light in at once.

THE FINANCES AND TRADE OF NEWFOUNDLAND.—The Hon. J. J. Rogerson in his budget speech estimated the revenue for 1880 at 979,602·61 dollars. Among the estimated items of expenditure are:—Relief of the poor, 143,705 dollars; steam service, 136,800 dollars; telegraph extension, 7,000 dollars; education, 88,860 dollars; roads and bridges, 103,000 dollars; geological survey, 5,500 dollars; drawbacks to shipbuilders, 17,000 dollars; drawbacks to bank fishery, 10,000 dollars; to encourage sheep raising, 1,000 dollars.

THE NEW FRENCH CABLE.—It appears that the very first message sent by the Brest and Penzance section carried the news of the breaking of the main French cable. It is not improbable that a considerable period will be required for the repair of the cable, the fault being, rumour says, in deep water. It is well to mark how correct were the forecasts of those whose knowledge of cable-work is best. The shares of

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this new company were issued at 512·50 francs; they are now quoted at from 300 to 315 francs, or nearly 45 per cent. below par. It would not be difficult to foretell the future of the cable; but, at any rate, the decision of the public that the cable was not wanted has been amply proved by recent events.

Electric Light.—The trial of the Brush light on board the Inflexible has proved satisfactory, and it is decided to use the light for the mast head and bow lights of ironclads. Portsmouth Dockyard will also be illuminated by the Brush light. Each light gave about 2,000 candles, at a cost of about 2d. per hour. A large corporation is, we believe, to be formed shortly in London, with a capital of £100,000, to test different systems of electric lighting and work the field. Next winter a considerable business is expected to be done in this mode of illumination. The city of Wabash, Indiana, U.S., as we have before stated, is entirely lighted by 4 Brush lights of 3,000 candles each, suspended 50 feet above the business part of the town. A No. 5 generator and a 7 H.P. engine sufficed, and the light gave general satisfaction.

The Cost of Gas at Paris.—According to official documents of the Paris Municipal Council, the illumination of the Paris streets costs the city about 4,240,000 francs. The number of burners is about 38,400, and of these 4,000 are extinguished at midnight, so that 34,400 remain burning the whole of the night. The longest time of illumination is during three consecutive nights—December 23 to 26. The lighting commences at 4:45 p.m. and extinction takes place at 7:15 a.m., giving a duration of fourteen hours and a-half. From June 15 to 26 occurs the shortest time of illumination. This commences at 9:05 p.m. and terminates at 2:30 a.m., giving five hours and twenty-five minutes illumination. The above figures for public lighting are increased by 405,100 francs for the coming year. It remains to be seen whether improvements in electric lighting will not lead to its adoption at a lower cost. It is hardly necessary to say that its adoption simply depends on its price.

The Electric Light at Woolwich.—Among the interesting results springing from the great Docks at North Woolwich, will be a most complete exhibition of the value of the electric light for dock and harbour purposes. The London Light Company have, by permission of the London and St. Katherine Docks Company, erected along the entrance of the existing Victoria Docks several lamps, so as to show the special characteristics and power of their system; and the Anglo American Electric Light (Brush Light) Company have also, it is said, obtained the sanction of the company to exhibit their light within its premises. But the new Victoria Dock is that which will chiefly claim attention; the company having contracted with Messrs. Siemens Bros. for lighting the whole length of this dock and dry docks, with the roads and railways on both sides of them, with the electrical light, on the Siemens system. This will be effected with 28 or 30 lamps, each of 6,000 candle-power, and each placed at an elevation of from 60 to 80 feet above quay level. The light will enable work to be carried on by night, in cases of necessity, as well as by day. The same system is, we are informed, arranged for Holyhead Harbour and for Barrow-in-Furness.

Contact Electricity.—M. H. Pellat has devised a new method of measuring the electricity developed by the contact of two metals, which permits of great precision. It is a compensating method based on the principle that if the two metals are connected by a wire they take the same difference of potential as if directly brought together. M. Pellat breaks the wire at a point, and introduces between the two ends previously joined, a graduated difference of potential variable at will, which is made to neutralise the difference due to the metals, and give a *nil* reading. The adjustible difference of potential is got by passing a constant current through a Pouillet rheostat; the resistance between the zero + sliding contact giving the electromotive force. A thousand divisions of the scale correspond to the E.M.F. of a Clark cell. The method gives results to 1-500 of a Daniell cell. The results are that the differences of potential vary with the state of the surfaces and the temperature; metals being more + when the temperature is high, and − when low. These differences also depend on the nature and pressure of the gas surrounding the metals. With copper and zinc, when the pressure of the gas diminishes, the difference of potential increases, especially with oxygen, nitrogen, and dry air. These differences are, however, slight.

Royal Society of Edinburgh.—The eleventh ordinary general meeting of the session of the Royal Society of Edinburgh was held on Monday evening, Professor Douglas Maclagan, vice-president, in the chair. Several valuable papers were read. In a paper entitled "On Currents produced by Friction between Conducting Substances," Mr. James Blyth described a new form of telephone receiver in its relation to the microphone, and the transmission of the sounds of a violin. Dr. Alexander Macfarlane, M.A., submitted one on "The Positive and Negative Discharge between a Point and a Plate, and between a Ball and a Plate." As the result of an elaborate series of measurements, he finds that the ratio of the electromotive force when the point is positive, to the electromotive force when the point is negative, is greater than unity, and that the opposite is true to the case of the ball. A paper was communicated by Professor A. Crum Brown, from Dr. E. J. Mills, F.R.S., Glasgow, on "Thermometric Researches," and it was announced in the course of the proceedings that the Keith prize for the Biennial period, 1877-79, had been awarded to Professor Fleeming Jenkin, C.E., F.R.S., for his paper on "The Application of Graphic Methods to the Determination of the Efficiency of Machinery."

The Electro-Motograph Effect.—The *Journal de Physique* describes an experiment of Herr Koch's which bears on this subject, and is of similar import to the experiments of Mr. Bidwell recently exhibited before the Physical Society, and described in our pages. When a plate of platinum or palladium is polarised by means of an electric current, the friction of these metals against a plate of moistened glass increases immediately. To measure the friction, the metal is used in the form of a hemispherical button, resting on the bottom of a glass cup, filled with pure or acidulated water. The button serves as pivot to a magnetic needle, which oscillates under the action of the earth; the decrease of the oscillations measures the friction of the pivot. Polarisation is produced by the current of the Daniell element, one pole of which communicates with the metal button, while the other terminates with a platinum wire entering the water of the cup. The hydrogen pole gives no effect, but the oxygen one does, the friction being increased in the ratio of two to three or four. The increase appears immediately on closing the circuit, and disappears immediately on reversing the current, but only slowly diminishes when the circuit is opened. It increases with the electromotive force. Palladium behaves like platinum, but Herr Koch found that 18-carat gold gave no effect.

Anderson's Galvanic Battery.—In this battery the elements may be zinc and carbon, the exciting solution for

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the zinc is preferably a saturated solution of sulphate or chloride of magnesium, and, according to the specification, that for the carbon is "*oxalate of chromium and potash* in combination with free bichromate of potash and muriatic acid, or a muriate or a chloride." The battery as constructed by the inventor may possibly work satisfactorily in certain cases; but the description given of it scarcely affords a clue to the *rationale* of its action. The use of a salt in which chromium is the *base* appears clearly to be a mistake: such a salt would be merely a battery residue; a good oxidant, viz.: chromic acid being rendered valueless in its production. The use of a salt such as bichromate of potash (in which the chromium forms part of the *acid*) in admixture with an acid (such as oxalic acid), is of course quite intelligible; but the following appears to indicate that the use of the deoxidised compound is really intended:—"Oxalate of chromium and potash may be formed by neutralising a solution of bichromate of potash with oxalic acid until effervescence ceases, or by mixing a solution of bichromate of potash with an oxalate, whereby either with or without the assistance of acid for dissolving the said oxalate, oxalate of chromium alone or a compound oxalate containing chromium is formed by the superior affinity of oxalic acid for chromium over almost any other base or salt." Will someone amongst our chemical readers state the precise reaction which gives rise to the effervescence here mentioned? The effective depolarising agent in working the battery as described would be chlorine, evolved by the reaction between chromic and hydrochloric acids. One of the claims made by the inventor is the use of "flour of sulphur for allaying and preventing the emanations of chlorine."

The Edison Lamp Tests.—Professor Morton writes to the Editor of the *Scientific American* a reply to Mr. Ramsdell's criticism of the tests of Edison's lamp. Mr. Ramsdell's letter will be found on page 293 of our issue last week. The following is Professor Morton's reply:—Your correspondent, Mr. William C. Ramsdell, in his letter of April 9, in your issue of May 1. p. 281, shows that he is unacquainted with the very elements of the subject about which he writes, and criticises the conclusions reached by myself and others only because he does not understand them. In the first place he seems to think that electromotive force is the same thing as the energy involved or work done in a given circuit. If he had examined any of the text books on electricity he would have found that electromotive force expresses simply the specific power which any combination (battery or magneto-electric machine or the like) possesses for causing the transfer of electricity from one place to another. In a given couple, say a Smee battery, it is the same in a cell the size of a thimble and in one as large as a bath-tub. It is very correctly measured by the product of the current into the resistance where these are known, but when its value is obtained we have *not* found that of the energy expended or work done in the same circuit. For the latter we must have the product of the current *squared*, into the time, into the resistance, into the constant ·737335, if we would express the result in foot pounds. Had Mr. Ramsdell been acquainted with these matters he would have been saved the absurdity of announcing that it would require the same expenditure of fuel to run twelve lamps as it would be needed to run one. It is curious that this *reductio ad absurdum* of his own did not open his eyes. Why should he stop at twelve lamps? His own method of calculation would give him the same result with a thousand, or a million, and thus reduce the cost of lighting the country to that required for one lamp. It is hardly necessary to point out that in the calculations made in our paper it was *not* assumed that the twelve lamps were in series. Theoretically it would make no difference as to the total energy expended how they were arranged, but, of course, any one acquainted with the subject would know that to place them in series would introduce great practical difficulties. Our calculation as given is correct for an arrangement in parallel circuits; but Mr. Ramsdell's calculations are simply absurd.

Compasses.—From some recent decisions of the magistrates and their assessors with reference to the magnetic courses steered by iron ships, it would appear to be necessary, says the *Nautical Magazine*, that they should have before them, when considering their judgment in cases of inquiry, a simple and plain statement as to the compass deviation of iron ships and the usual method of tentative compass adjustment as practised in the Mercantile Marine. The magnetic character of an iron ship is represented by five co-efficients:—A. Constant deviation; B. C., Semicircular deviation; D. E., Quadrantal deviation. Besides these there is another error which in some ships is very considerable, viz., the heeling error. As the co-efficient A is a constant and is generally very small, it is not for the present purpose necessary to enlarge upon it. B and C are two co-efficients representing the semicircular deviation, so called because it is easterly in one semicircle and westerly in the other. It consists of two parts, the induced magnetism, caused by vertical induction in soft iron, which varies as the tangent of the dip, or as it is sometimes called the magnetic latitude, and the permanent magnetism which varies inversely as the earth's horizontal force at the place. If the exact proportions of these two parts were accurately known and remained unchanged, the alteration in the semicircular deviation might be calculated for a change of magnetic latitude, but this is not the case. For convenience, the semicircular deviation is arbitrarily divided into two parts, represented by B and C. B represents the fore-and-aft magnetic forces of the ship, with its zero deviation when the ship's head is N. and S.; its maximum when the ship's head is E. and W. It is corrected by the compass adjuster by placing a magnet or magnets in a fore-and-aft line, with their centres in a tranverse line with the centre of the compass. C, which has its zero E. and W., maximum N. and S., is corrected by placing magnets athwartships, either forward or abaft the compass or both, with their centres in the same fore-and-aft line as the centre of the compass. D and E are co-efficients, representing the quadrantal deviation, caused by horizontal induction in soft iron, and when properly corrected by soft iron placed on the same level as the compass needle, remain correct for all latitudes. The heeling error when large, is compensated by a magnet placed vertically under the centre of the compass and is only correct for one latitude. The object of this paper is to impress on magistrates and assessors that as the semicircular and heeling deviations alter with the position of the ship on the earth's surface, that the deviation table supplied by the compass adjuster is only correct for the place where the ship was swung, and that the responsibility rests with the master to ascertain the change in the deviation of his compass by constant observation of heavenly bodies, both day and night, when the weather permits. Further, that if the ship be swung and her compasses corrected by magnets in the northern hemisphere, that it will generally be necessary in high southern latitudes to reverse the poles of the fore-and-aft magnets, correcting co-efficient B; that the (vertical) heeling magnet will require constant attention and alteration of position as the ship alters her latitude, and in high southern latitudes it will probably be necessary to reverse its poles.

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CORRESPONDENCE.

SEEING BY WIRE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The idea of utilising the photo-electric property of selenium as a means of transmitting light by electricity has occurred to many electricians; but probably few have taken the trouble to devise a theoretical solution of the problem as has been done by Professors Perry and Ayrton. Their plan, however ingenious, is avowedly too elaborate. Moreover, it would give but a very imperfect copy of the original image, and is, therefore, not very practical. It seems to me that better success would be attained by trying to find a mode of transforming the electricity back again into light by a reversal of the physical process which transforms light into electricity, rather than by devising a complex mechanical arrangement for reproducing the image. So far as I have read no experiments have been made to see whether the electricity developed in selenium by the impact of light will not by a purely contrary action develop a corresponding amount of light again. Might not a powerful ray of light falling on a polished surface of selenium be made to yield a bright spot of light on another speculum of selenium? If a circuit is necessary to this experiment the selenium surfaces could be turned into miniature condensers and observed in the dark, one plate receiving the exciting light, while the other is watched to see if it show any sympathetic illumination. If this experiment succeeds, the construction of a simple "telephote" by means of small images (magnified after) is obvious.—Yours, &c.,

J. MUNRO.

PHYSICAL SOCIETY.

MAY 8.—Sir WILLIAM THOMSON, President, in the chair. New members: E. F. Bamber, Dr. E. Obach, R. D. Turner, E. Woods, H. E. Roscoe, and H. Watts.

Professor MINCHIN, of Cooper's Hill Engineering College, described his further researches in the subject of photo-electricity brought by him before the last meeting of the society. He has found that the current in a sensitive silver cell does not always flow from the uncoated to the coated plate. It does when chloride or bromide of silver is used, but when the sensitive emulsion is iodide of silver, and the liquid water tinctured with iodide of potash, the current is from the coated to the uncoated plate. He demonstrated that the current set up by the fall of light on the cell could be sent by wire to a receiving cell, and made to produce a *local* effect on the sensitive plate therein. He also proved that electricity is developed in fluorescent bodies by the action of light, and hopes to show that it is also developed in phosphorescent bodies. Neither heat nor the red rays produce this electricity, but it is the blue and violet rays which do so. The fluorescent silver plates he employed were coated with an emulsion of eocine and gelatine, and had kept sensitive for twelve days. They would then be a permanent source of photo-electricity did the eocine not tend to leave the gelatine. Mr. Wilson had suggested napthaline red for eocine, as not apt to leave the gelatine, and he had found it give good results.

Dr. O. J. LODGE described certain improvements which he had made in his electrometer key designed for delicate electrical and especially electrostatic experiments. Assisted by the British Association, he had made it more convenient, and fitted it into an air-tight case, which could be artificially dried. The contact pins were now of phosphor-bronze, gilt, instead of platinum; and the contacts were made by press pins from the outside. Dr. Lodge also exhibited a new inductometer, or modified form of Professor Hughes's induction balance, combining a Wheatstone balance, and expressly designed for comparing capacities and resistances, especially the resistances of coils having no self-induction. A telephone takes the place of a galvanometer in the bridge; and the current in the primary coil is interrupted by a clockwork make and break. There is one primary coil of fine wire $3\frac{1}{2}$ ohms in resistance, and two secondaries, one on each side of it, of fine wire, each about 270 ohms. These are fixed, but the primary is adjustable by a screw.

Professor HUGHES remarked that he had pointed out in his paper to the Royal Society that the induction balance could be used in this way; and

Dr. LODGE disclaimed any novelty in the apparatus beyond its arrangement.

Sir W. THOMSON added that it was satisfactory to see so serviceable an adaptation of the induction balance to research.

Dr. HOPKINSON, Professor PERRY, and Sir W. THOMSON offered remarks on the element of time in comparing discharges from condensers of different dielectrics.

Sir WILLIAM said that in 1864 he had made experiments on air and glass dielectrics, and found the discharge about the same for the first $\frac{1}{4}$ second.

Professor Adams then took the chair, and

Sir W. THOMSON made a communication on the elimination of air from a water steam pressure thermometer, and on the construction of a water steam pressure thermometer. He said it was a mistake to suppose that air was expelled by boiling water, because the water dissolved less air when warm than when cold. The fact was due to the relations between the density of air in water and the density of air in water vapour. There was fifty times more air in the water vapour, over water in a sealed tube, than in the water below. If this air could be suddenly expelled only $\frac{1}{50}$ part of air would remain, and of this only $\frac{1}{2500}$ in the water, the rest being in the vapour. This suggested a means of eliminating air from water, which he had employed with success. It consisted in boiling the water in a tube, and by means of a fluid mercury valve allowing a puff of the vapour to escape at intervals. Sir W. Thomson also described his new water steam thermometer now being made by Mr. Casella. It is based on the relations of temperature and pressure in water steam, as furnished by Regnault's or other tables, and will consist of a glass tube with two terminal bulbs, like a cryophorous, part containing water, part water steam, and the stem enclosed in a jacket of ice cold water. Similar vapour thermometers will be formed, in which sulphurous acid and mercury will be used in place of water, or in conjunction with it. For low or ordinary temperatures they will be more accurate than ordinary thermometers.

THE FRENCH SCHOOL OF TELEGRAPHY FOR ADVANCED STUDENTS.

BY FRANK GERALDY.

[Translated from *La Lumière Electrique*.]

It has frequently been pointed out, unfortunately with good reason, that in recent periods the history of electricity has made mention of but few names belonging to our country. It records many English, American, and German, but few, too few French names. It is true that at the commencement of the present century, at the origin of this branch of physical study, France took a notable, even a predominant part in the work that was done; but since, and especially in the practical period we are entering, her activity seems to have slackened. Hitherto the most important application of electricity has been in the direction of telegraphy; and it is regrettable to have to admit that, of the apparatus and processes in present use, scarcely anything belongs to us. Morse and Hughes are American, Wheatstone is English; the great enterprise of submarine telegraphy, with the series of theoretical and practical studies it necessitated, was carried into effect independently of our action; amongst the eminent names in connection with it, including in the foremost rank that of Thomson, we recall none belonging to our nationality.

It is not, however, that at any time our country has ceased to possess men of the highest value in electrical science. It would be useless to quote here names that are known to every one. On the other hand we have a staff of most intelligent and well-informed telegraphists, whose qualifications are more than adequate for their ordinary work. We are forced to conclude that, whilst our men of science, engaged in theoretical studies, have been unable to enter into the practical realisation of new ideas, our telegraphists, absorbed by their constantly-increasing duties, can rarely find sufficient time for the lengthy researches and difficult experimental work requisite for the production of a new apparatus.

There are to be found, however, amongst our telegraph engineers a number of men of superior knowledge and experience; and the ingenious improvements and novel apparatus devised by them begin to constitute a very satisfactory total. But this is of comparatively recent date; and those who have obtained such high standing have of their own initiative, and without any arrangements being made to facilitate their work, added to their theoretical knowledge special studies in the direction of practice, or *vice versâ*.

The eminently useful superior School of Telegraphy, esta-

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blished in 1878 by the initiative of the Minister of Posts and Telegraphs, is at the present time removing the difficulties in the way of such work, and assuring the due recruitment of the technical staff. It is the duty of those who are engaged in electrical science to draw attention to so useful an institution and to bring its advantages prominently forward.

When the institution in question was first projected, it was necessary to decide what courses of instruction should be given, and, consequently, what preliminary knowledge was requisite on the part of the students. It was then seen how vast is the art of the telegraph engineer. He in fact requires :—

1st. A complete knowledge of the higher mathematics to enable him to understand the papers, of such frequent occurrence at the present time, in which electrical questions are attacked by algebraic means, and also to enable him to utilise and perfect the methods of electrical measurement of which the urgent necessity is so strongly felt.

2nd. A complete knowledge of physics; for at the present moment we have electrical, pneumatic, acoustical (harmonics, telephones, &c.), optical, and thermal telegraphy; and who knows what may not be invented to-morrow.

3rd. An extended knowledge of chemistry; this does not require to be insisted upon, for it is understood that the production of electricity and many other questions in telegraphy involve certain chemical reactions.

4th. An extended knowledge of mechanics; since the complications of apparatus are every day increasing, and the most various scientific devices are now employed.

Lastly, all the practical knowledge pertaining to his art; and the list of the courses of instruction will show that this is extensive.

After this review, bearing in mind that this school should supply the state with engineers, the mode of recruiting it seems to be clearly indicated: it should apply to that nursery from which the state obtains its special servants, *i.e.*, to the *Ecole polytechnique*.

Influenced by a liberal idea, which I, for my part, strongly endorse in the interest of the service and of the school itself, the minister has not confined himself to this source only; instead of a close school and service, it has been his desire to establish an open institution, and he has sought students wherever sufficient guarantee could be obtained as to the requisite preliminary studies. Licentiates of science and young men leaving the school of mines, of bridges and roads, the polytechnic school, the central school of arts and manufactures, the normal and naval school, and the school of forests may, after competition, enter the advanced school of telegraphy.

Lastly, concluding, with reason, that acquired experience should be taken into account and duly considered, the Minister decided that the school should be accessible to agents of the posts and telegraphs who have seen sufficient service and acquired sufficient knowledge. He did more than this; perceiving that it is difficult for agents to find during their service the time and the means for acquiring theoretical knowledge, he conjoined with the advanced school a preparatory *annexe*, to which are admitted those agents offering due guarantees, and where they may place themselves in a position to compete for admission to the advanced school.

Moreover, the school receives young foreign engineers accredited by their Government, and admits them to all the courses of instruction.

The latter are divided into two parts: the courses, properly speaking, given some to this school, others to the school of bridges and roads, and the practical instruction.

The school has for its director M. Blavier, superintendent engineer of telegraphs, and for inspector of studies M. E. Mercadier.

The courses at the school are ten in number :—

Physics applied to telegraphy.—Professor.....	M. E. Mercadier.
Chemistry applied to telegraphy.—Professor...	M. Seligman-Lui.
Practical telegraphy.—Professor	M. Ch. Bontemps.
Military telegraphy.—Professor	M. Ct. Morris.
Telegraphic exploitation.—Professor	M. Fribourg.
Postal exploitation.—Professor.....	M. Ansault.
Construction of lines.—Professor.....	M. Boussac.
Electrical measurement.—Professor	M. Raynaud.
English.—Professor.....	M. Sevrette.
German.—Professor.....	M. Leser.

Courses for the school of bridges and roads :—

Railways.
Steam engines.
Administrative law.
Architecture.

In addition to the above, conferences on special subjects are held with the students by the most distinguished *savants*, amongst whom may be mentioned MM. Cornu, Mascart, Marcel Deprez, Sarrau, Lartigne, &c.

The practical tuition comprises :—

The manipulation of apparatus.
Exercises on electrical measurements and tests.
Construction of apparatus.
Freehand drawing.
Riding.

[It should be borne in mind that all these young men bear rank in military telegraphy, and have every year to go through certain manœuvres, which are now taking place.]

Besides the School there are its annexes, viz. :—

The preparatory school for agents, which has been referred to above; here there are four courses, mathematics, physics, chemistry, geographical drawing.

The course of instruction for mechanics, intended to give to the most intelligent working mechanics a higher degree of practical and theoretical instruction. It comprises courses relative to the ordinary apparatus, exercises in construction and repairing, and free-hand drawing.

I cannot dwell upon the programmes of all these courses, which seem to me to be at the same time complete and practical; I will call attention only to the course on postal exploitations, which is novel, and seems likely to be productive of very good results, by rendering it possible to take a general view of a service which has always been treated very empirically.

The courses last for six months; the students have then a three-months' mission; they are attached to a district which they have to traverse, studying the arrangements of the posts and telegraphs, taking part in the service, examining and working the apparatus, and finally bring back with them a journal giving the results of their work.

The school only being in its second year, there has as yet been but one mission; but it appears that the journals brought back were very satisfactory, some of them remarkable, containing original views which are susceptible of application.

One month is taken up by the military manœuvres in telegraphy at various camps.

The rest of the year is vacation.

There remains to be referred to an important *annexe* of the school, *i.e.*, the laboratory of tests and researches.

Even for the instruction of young engineers it was found expedient to put up for use various apparatus for measurement and research, as well as a workshop where the students might witness the construction of, and themselves construct, various pieces of apparatus. By a slight extension, the addition of a few batteries and tools, the scope of this laboratory was successfully enlarged, and it became the laboratory for tests and researches, where novel ideas may be studied out, and where the committee of improvement, reorganised in 1878, may have carried out those tests and measurements which appear to it useful. In spite of the recent period of its foundation, some ingenious work has already proceeded from this laboratory, and some very remarkable ideas are now being worked out.

The school at present numbers seven students in their first year and six in the second, who will leave as assistant engineers there is also a Belgian engineer sent by the Government of his country. There are four students at the preparatory school.

The school is in the building of the central telegraph station, Rue de Grenelle. At the bottom of the great courtyard of this establishment a door opens into a small secluded courtyard, surrounded with low buildings; to the left are the laboratory buildings, furnished with their galvanometers and improved electrometers ingeniously arranged for convenience in use, and also the workshop; in front is the inspector's office and the lecture room for the preparatory courses; to the right the physical cabinet which is not yet very rich, but nevertheless contains some curious instruments, the manipulation rooms, and the lecture hall; and lastly, behind the observer are the testing and measuring rooms, and the chemical laboratory. The space is a little confined, but yet is sufficient, there is good light, and the aspect is quiet without being melancholy.

We owe to the initiative of the minister for posts and telegraphs a school which is not equalled in any other country, either for the extent of the courses of instruction or for the breadth of the mode of recruiting. It will soon be productive of results which are very certain, and it gives us the right to expect still more. We are convinced, in fact, that within a few years it will supply us with a body of telegraph engineers which will yield to no other country in theoretical and practical knowledge, whilst at the same time it will have a coherence due to the unity of its origin.

We may on the other hand hope, almost with certainty, that from the hands of these engineers and from the laboratories of the school we shall obtain apparatus constantly perfected, and that the need of rapid communication over great distances, which is every day developing so strongly, will be satisfied to the greatest possible extent.

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THE ELECTRICIAN.

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A NEW BROOM.

The newspapers have not been slow to gratify the curiosity which has followed the appointment of Mr. Fawcett as Her Majesty's Postmaster General. Already the British public is informed that one moiety of its reward for having returned to virtuous courses will consist of large measures of reform in the administration of the Post Office. The spectacle of a newly fledged minister rushing down to the official rooms of a Department of which he knows absolutely nothing, and announcing his intention of introducing large or small measures of reform is one which only the imagination of a daily "organ" would be capable of conjuring up. Somebody once thanked God that we had a House of Lords. For much the same reasons, if the picture we have just referred to had any foundation in fact, we should be thankful that we have a permanent Civil Service. The latest published details of these threatened innovations, however, appear to be only such as the late Postmaster General was known to have meditated, and some of which were ripe for adoption. The public will therefore probably have to wait a reasonable time for those sweeping changes which are supposed to be peculiarly attractive to new brooms of a certain political colour.

Apart from the temptation just hinted at, there is, we believe, nothing to mar the general satisfaction in the appointment of Lord John Manners' successor. He is a man of pre-eminent ability, and his inexperience as an administrator will scarcely be felt in a branch of the public service which would work without a parliamentary chief probably quite as efficiently as with one. But, being represented in Parliament, the Post Office is peculiarly exposed to the meddling of busybodies, and the crotchets of doctrinaires. So long as it was a mere carrier of letters, no harm came of the interference; but since the transmission of messages by purely technical and scientific agencies fell into its hands the case has been different. It is, of course, with this aspect of the subject that we are most concerned; and when we recollect that foremost among the interrogators of the late Postmaster General in the defunct Parliament were men who have been put into positions of influence in the new, we confess we are not without some apprehensions as to the future of the telegraph service.

If, however, there are some measures to be feared there are others that we may reasonably hope for from the new administration. First among these in point of time, if not of foremost importance, is a settlement of the dispute with the telephone companies on a more liberal basis than seemed to find favour with Mr. Fawcett's predecessor. The public has already come to regard the facilities which these private companies afford, but which the Post Office could not undertake if it would, and probably would not if it could, as indispensable luxuries of commercial and even private life. It is clear that the Post Office ought not to forego its claims to a profit on these transactions; but we hope that they will not be pressed to the hampering of the private ventures or curtailment of public convenience. A royalty upon the net receipts is the best suggestion we have as yet heard, and it will probably not be difficult to effect a speedy compromise on some such basis as this.

Another matter, in which we fear these companies are becoming greatly implicated, and which calls for reform, is the alarming extension of overhead wires. The other day we counted one hundred such wires, without turning about to count more, crossing one of the busiest thoroughfares of the City of London. The same thing is going on in provincial towns. We feel sure there is a limit to the patience of the public, as there assuredly is to the safety of the system, and those limits are now pretty nearly reached. The Post Office has, we believe, very largely reverted to an underground system; and it is not directly responsible for the public danger here referred to; but to the Post Office we must look for the initiation of corrective measures; and the planning of underground troughways to accommodate all parties should be the work of this department exclusively.

A great deal of interest in the technical instruction of the staff was displayed by the last Parliamentary Committee which sat upon telegraphic affairs. It was generally urderstood at the time that the committee were in favour of teaching all working telegraphists at least the elementary principles of the agency with which they had to deal. What steps have been taken in this direction we have no means of ascertaining; but we believe we may safely assert that the instruction has not been carried to anything like the length contemplated by the committee. With the advent to power of that political party from the ranks of which the committee was mainly selected, we may expect to see this subject come once more to the front. The value of technical instruction is being recognised in almost every branch of manufacture and industry. We do not hear that it is denied in respect to the telegraph clerk; why, then, it continues to be withheld is more than we can account for. The amount and the character of the technical knowledge desirable are open to discussion; and certainly they can be answered only by the scientific advisers of the department, not by the dicta of unpractical outsiders. But that these questions ought to be answered we are fully persuaded; the credit of the service, as well as the interests of the public, demand it.

One of the reforms upon which the late Postmaster General was engaged was an expansion of the present system of remitting money by post. It may not be out of place, there-

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fore, to mention a singular deficiency in the existing system of remitting—or more strictly speaking, advising—money by means of the telegraph. At present the privilege is, we believe, confined to a very few large towns—to places, in fact, where, bankers being plentiful, the system is hardly needed. What we would advocate is an extension of this system to all money order offices, limiting it, of course, to small amounts. It is small sums of money which travellers or tourists often quite suddenly find themselves in need of; and if a telegram to a friend would bring the authority to pay the needful in the course of an hour or so, we feel sure that the boon would often be greatly appreciated. This is not an ambitious project; but it is one of the legitimate uses to which the "swift messenger" might be put, and we can see no practical reasons for denying it.

The subjects of reduced tariffs, employment of females, fast speed telegraphy, and the like, have so recently been discussed in our columns that we need not now go over the ground again. If they are revived under the new Administration we may have something more to say about them.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).

The 13th half-yearly general meeting of the above Company was held on the 7th May, 1880, at the Cannon-street Hotel, under the presidency of Viscount Monck.

The SECRETARY (Mr. Richard Collett) read the notice convening the meeting, and the minutes of the 12th ordinary general meeting, held last October. The directors' report, an abstract of which appeared in *The Electrician* of the 1st inst., was taken as read.

The CHAIRMAN, in moving its adoption, said that it was always the endeavour of the directors to make the report full and explicit, so that the shareholders might see what the state of the Company was, and how the affairs of the enterprise had been conducted in the six months to which it related. The first point he wished to draw their attention to was the amount of the receipts for the half year ending the 31st December, 1879. They amounted in gross to £77,504, and showed an increase of £2,421 over those of the previous half year. As, however, he had often told them, it would be unfair to compare the two successive halves of the year, because one half was always better than the other; but, compared with the corresponding half of last year, there was an increase of £12,408. If they referred to the summary of the traffic receipts appended to the report they would see that there had been a gradual though small increase from the beginning of their working. There had been a gradual average increase of between £2,000 and £3,000, but he was happy to say that the increase this half year was more substantial. The traffic receipts for the past half year amounted to £77,177, which, doubled and compared with the previous year, would show an increase of something like £14,000 or £15,000. He was happy to inform them—as they might know by consulting the periodical publication of the receipts—that their receipts had gone on increasing, and this half year he expected they would be the best they had ever had. That was satisfactory in itself; but still, he confessed that the receipts of the Company had disappointed him. When the Company was started, looking to the volume of trade between Europe and Brazil, and to the receipts obtained by other large telegraph companies, they had, he thought, a perfect right to calculate on very much larger returns than they had obtained; but if they looked at the date at which their traffic opened they would find that it was just at the time—unfortunately for them—at which the depression of trade, which had affected the whole world, set in. It was in the year 1874. He, however, trusted that the change in their receipts to which he had alluded warranted them in expecting in the future that return on their capital which they had the right to look for. As to the expenditure of the half year, it was £1,958 less than in the previous half year, when they incurred special expense. Leaving that expenditure out of the account the expenses of the two half years were pretty equal, so much for their receipts and expenditure. The only other subject alluded to in the report was the litigation which had been going on between them and the Western and Brazilian Telegraph Company, and they were so fully aware of all the bearings of the case that it was unnecessary for him to go into it at any length. They raised four questions upon the articles of agreement between them. The first was as to the proportions of traffic they exchanged, and they endeavoured to obtain a revision of those proportions. He regretted to say that that point had been decided against them, as it was really the important question for them. The second point related to the period of interruption in the working which should be allowed before either party ceased to have the advantage of a division of the profits. The third point had been settled in their favour, and it was decided that they should have a monthly settlement of the balances between them instead of quarterly. The fourth question they raised was that they should be entitled to reconsider their arrangement at the end of every three instead of at the end of every five years, and that point had been conceded to them. He could only say further on this subject that, as they were aware, the agreement with the Western and Brazilian Company had been a source of vexation and annoyance to them all, and he thought they would consider that the Board were justified in trying, by every means in their power, to have that agreement rectified. However, the direction of the Western and Brazilian Telegraph Company had now changed hands, and he hoped that the fresh blood thus introduced into that company would enable them to work with more regularity and efficiency than hitherto. The Company's cables were in good working order and efficiency, and should the development of the Brazilian trade cause them to have more messages, he could only say that they were able to do a large amount of additional business without any additional cable power. A matter which did not arise on the report, or, indeed, at that period of the year, but which had engaged the attention of the Board, and had been the subject of discussion at previous meetings, was the question of dividend—the amount of dividend. He wished to lay the question fully and impartially before them. There was no shareholder who would not admit that it would be much more pleasant and agreeable to him to declare a large dividend, and so make things pleasant all round, but he would have to put them in possession of what he believed were the facts of the case, and allow them to draw their own inferences from those facts. The first point in this question which he desired to draw their attention to was the length of their cable. It was in three sections, amounting in the aggregate to 3,671 miles. They had been paying five per cent. dividend from the opening of the Company, and they had been enabled to lay by £280,000 to reserve fund. It had taken them six years to do that. If any one or two of their sections were to break down, and they did not possess in their reserve fund the means of restoring them, the only way they could keep the enterprise on its legs would be to raise fresh capital. The very least they would require to raise would be £300,000 or £400,000, on which they would probably have to pay six per cent. interest; and he asked them, as men of business, whether they thought the traffic of the Company would bear that addition, enable them to pay five per cent. on the original capital, and to lay by anything worth mentioning to the reserve fund? He asked them to consider that question before they demanded more dividend. He might be told that it was not probable that all three sections of their cable would break down at once, and he was quite aware of that. One section might last a great deal longer than the others, but, on the other hand, they must remember that, sooner or later, they would have to renew all the three sections; and judging from what had taken place in other companies and with respect to other cables, though they might not have to do it at the same point of time exactly, they would have to do it, within certain limits, at about the same time. His own opinion—and it was only right to the shareholders that he should express it unhesitatingly—was, therefore, that they should lay by a reserve fund till they had sufficient for the renewal of the cables for the whole distance. It was also to be remembered that if they went into the market it was not very easy to get money in the first instance, and, in the next place, if they did not get their cable constructed with ready money they would have to pay more for it. On the whole, therefore, he thought it was better for them to be satisfied with a moderate dividend, and to put by an adequate reserve fund; but, on the other hand, there was no doubt that their receipts were increasing. They had had within the last year the only real substantial increase they had ever had, because, though there was a considerable apparent increase last year, they all knew that that was very much owing to the Cape war. That source of revenue was at an end, and did not affect this half year, and yet this half year the receipts were larger than they had ever been. He was not without hope, therefore, that if the traffic continued increasing they would be able to lay by sufficient to the reserve fund and increase the dividend also, and he assured them that there was not a member of the Board who would not be delighted to give

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them 10 per cent. if it could be paid. They were very anxious to increase the dividend if they could do so consistently with the true interests of the Company. They would give the subject the most anxious thought before the next meeting, and if they found they could give a larger dividend nothing would give them more pleasure. He concluded by moving the adoption of the report.

Sir JAMES ANDERSON (the vice-chairman) having seconded the motion, a discussion followed.

Mr. URWICK contended that the time had arrived when they might have an increased dividend—say 6 or 6½ per cent.—and that everything would be done that was necessary if they in future transferred no more than £40,000 a year to the reserve. He thought it was the duty of the Board to do all they could to fulfil the promises they made in the prospectus.

Mr. MARSHALL echoed the sentiments of the previous speaker, and said, instead of the promises held out in the prospectus, they had to be content with a paltry 5 per cent. He strongly denounced the articles of association, held that theirs was the best property of all the telegraph companies, and concluded by moving as an amendment that "the report be not received."

The CHAIRMAN said that it was not an amendment, and that the hon. gentleman had merely to vote against the report.

Mr. GOODSALL quite approved of the policy of the Board as to the reserve fund, but could not agree with the proceedings which had been taken against the Western and Brazilian Telegraph Company.

Mr. MARSHALL withdrew his amendment, but expressed his strong opinion that the dividend should be increased.

Mr. HILL was also of the same opinion, and supposed that the directors felt they were acting judiciously in paying a dividend of 5 per cent. when they had only £40,000 in the reserve fund, as against £280,000 as at present.

Mr. GRIFFITH also argued in favour of an increased dividend.

Mr. JOHN NEWTON spoke of the satisfactory character of the report, and wished that the directors of other telegraph companies would publish a summary of their traffic receipts as this Company did. He supported the argument for an increased dividend. They would be quite satisfied with 6 per cent.; or, if that could not be safely paid, 5½ per cent. He contended that such an increase would beneficially affect telegraph property generally.

Mr. WARREN said he wanted an increase of dividend as much as anyone, but having listened carefully to the arguments, he confessed that he was not convinced of the propriety of their paying higher dividends. He believed that the policy of the Board was the soundest which could be followed.

The CHAIRMAN, in replying, repudiated the statement that the Board promised a large amount of dividend when the Company was started. They promised no dividend, but merely showed the volume of trade between Europe and South America, and compared that with the trade of other countries where there were telegraph companies. They therefore knew how the conclusions were arrived at, and the basis on which the calculations were made. They mentioned the ground of their anticipations, and the shareholders were as competent as were the Board to judge of the soundness of those anticipations. To pass to the question of the reserve fund, there seemed some misapprehension as to its purpose. Well, they were laying by money not only for the repair of the cables, but also to supply the place of the present cables when they are worn out. It was easy to say that they had an ample reserve, but what were the facts? Their present cables cost them £1,300,000, and knock off £300,000 for having ready money, did anyone mean to say that a sum much under £300,000 was sufficient provision for the expenditure of £1,000,000? These matters were perpetually before the Board. It was also stated that an increase in the dividend would bring up the price of the shares to par, but he was not quite clear about that. He thought that people who bought shares were pretty well advised first as to the condition of the company they invested their money in. The Eastern Extension Company had been referred to, and the shares were of the same nominal value in both companies. That company had pursued the policy of strengthening their reserves and duplicating their cables; they had never paid more than 5 per cent., and yet their shares were going up to par, which was owing to the wise policy of the directors of that company. As to the litigation with the Western and Brazilian Telegraph Company, they were advised not to give way by Mr. Webster, Q.C., and Mr. Finlay, both counsel of considerable eminence at the bar, and Lord Justice Thesiger stated in delivering judgment that he did not in the least wonder at the Company litigating the question. He had expressed their anxiety to pay a larger dividend next time if they found that they were able to do so. The report was then adopted.

Mr. GRIFFITH next moved "That in future a sum not exceeding £40,000 be transferred to the reserve fund annually, and that the next interim dividend be declared at the rate of 6½ per cent., or so much more than 5 per cent. as, after the application of the £40,000, can be paid."

Mr. MARSHALL seconded the motion.

The CHAIRMAN said the directors would protest against such a resolution, which, he said, could have no legal effect.

Mr. GRIFFITH ultimately withdrew the resolution.

A resolution was afterwards put, requesting the directors to pay a dividend not exceeding 6 per cent. whenever they were able to carry £50,000 to the renewal fund for the preceding year, but that no dividend exceeding 6 per cent. be paid until the renewal fund was sufficient to duplicate all the company's cables. This resolution, however, was almost unanimously rejected.

A vote of thanks to the chairman and directors terminated the proceedings.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).

The sixth ordinary general meeting of the members of the above Company was held at the City Terminus Hotel on the 12th inst., under the presidency of Mr. C. W. Earle.

The SECRETARY (Mr. C. M. Hooper) read the notice convening the meeting, and the report of the directors for the half year ending the 31st of December last was taken as read. It stated, *inter alia*, that the amount to credit of revenue was £35,630, and the expenses had been £22,474, leaving a balance of £13,155, which, with the balance of £1,631 brought from last half year's account, made a total of £14,787. Of this sum the directors had carried £2,000 to reserve, leaving £12,787 available, which it was proposed to deal with as follows, viz.:—First preference shares, half year's dividend to 31st December, 1879, at 6 per cent. per annum, £10,368; second preference shares, half year's dividend, at 6 per cent., £1,400; balance carried to current half year's account, £1,017.

The CHAIRMAN, in moving the adoption of the report and accounts, said that although the receipts showed a falling off of nearly £500 as compared with the corresponding period of 1878, yet the balance carried to revenue was about £500 better than it was at that period. This was attributable—first, to their having received £500 more for subsidy from Jamaica; and secondly, to their having had to expend less money in cable repairs; not that their cable repairs were less than they were at the corresponding period; but it so happened that less cable was used, which was a matter of luck. In that way they saved £2,000 in comparison with the corresponding half of 1878, which was a particularly heavy half year for repairs. They had had £1,500 less in subsidy on account of Demerara still withholding her subsidy, and they had also incurred additional expenditure for the hire of sloops to carry the traffic during the interruptions to which they had been subjected this half year. Still, their revenue was some £550 better. With regard to the reserve fund, on Dec. 31st, it stood, of course, exactly as it was stated in the accounts, but since then they had been obliged by the action of the underwriters in reference to the Investigator to provide a new ship and some more cable for the repairs of the system, and consequently they had had to dip into the reserve fund, and realise some of the investments on that account. Of course, that which was applied to the purchase of new cable was as good, if not better, as far as reserve purposes went, than having the money in Consols, which would have to be converted in case of need into cash, and the cable ordered and sent out. The cable might be considered a better reserve fund for their purpose than even cash. Their new repairing ship, the Grappler, as stated in the report, had sailed, and they had received a telegram to say that she had arrived safely, and she was now on her way to repair some interruption. They were fortunate in the autumn in making a contract for this ship, for they did it at a moment when materials were at their very lowest point. They called for tenders, and accepted the lowest. The contract price of the ship was £14,550, and they were assured that had the contract been made at the time the ship was delivered she could not have been contracted for under about £20,000. The whole cost of the vessel, with fittings, machinery, &c., would stand in their books at about £17,000. It had been a cause of disappointment and inconvenience to them, the action taken by the underwriters with regard to the insurance on their old ship the Investigator. They thought that the vessel was insured against all risks, and surely the blowing up of its boiler was a risk one would naturally think a steamer was exposed to in ordinary circumstances, and they believed she was covered by the policy. However, the underwriters did not think so, and notwithstanding that the company had got a very clear judgment in their favour by Lord Justice

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Baggallay, the case had been carried to the Court of Appeal. It appeared that a similar case had never been tried in any Court —a case of a vessel being wrecked by the explosion of her boiler, and the underwriters had determined to settle the point, and were fighting the battle over the Company's unfortunate carcass. This, of course, kept them out of money, and occasioned them inconvenience in that respect. The case would be before the Court of Appeal in a day or two, and he hoped they would soon get a decision upon the matter. With regard to the Demerara subsidy, the question between the Company and the Government of that Colony turned upon the interpretation of what was called the grace clause in the Demerara Act. He knew of only one telegraph Subsidy Act in which there was not a grace clause. A grace clause meant a certain time given on an interruption occurring during which the subsidy continued payable, always supposing that the company used in the meantime its best endeavours to repair the cable. The Attorney-General of the colony of Demerara had advised his Government that having once exhausted that provision—having once taken advantage of this grace clause they were no longer entitled to it in future breaks. They had laid the case and the Act before the Attorney-General of England, whose opinion did not uphold that of the Attorney-General of the colony. It was not for them to say which of those two eminent authorities was right, but they had put the opinion of the Attorney-General of England before the Government of of the Colony of Demerara, and he believed that in June the question would be discussed with the new lights they had before them. As to the general position of the Company, the refusal of the British Government to grant the Company the subsidy which they applied for was not, he confessed, a very great surprise to him. Mr. Abbott, on former occasions, had very truly said that he (the chairman) was not a sanguine man, and he certainly was not sanguine that the Government would make them the grant they applied for. It was their duty, however, to lay their position before them, and what they feared might be the eventual result of their having to continue to work with so inadequate a return. They all knew that public attention had been very much directed of late to the West Indies, but there had been no public excitement about the matter, and they knew that it required such a disaster as the Cape war to obtain a subsidy from the Government. Fortunately for the West Indies, they had not had such a catastrophe lately. He, however, thought the Government could not forget what occurred in Jamaica before the telegraph was constructed, and what a sad page in the colonial history of this country were the occurrences there, especially when those disasters might have been mitigated, if not obviated altogether, if the telegraph had been in operation. They had seen how beneficially the telegraph operated at St. Croix, where troops and ships were thus summoned to protect and give refuge to the white people flying from their burning farms and houses. He thought such occurrences might, at any rate, have some effect on the colonial mind in making them see the necessity of giving the Company some support. He observed that the refusal of this application by the British Government had had the effect of producing rather a better tone in the Press of the colonies. They began to see that, in all probability, some curtailment of telegraphic facilities must ensue if they did not get a better revenue, so as to enable them to put by a considerable reserve towards the depreciation of the cables. They were now considering the best and most effective means, and the best time for putting their views before the Colonial Governments, and he could only express a hope that they would look at the whole matter in a business-like and favourable view. He concluded by moving the resolution.

Mr. WILLIAM FORD, having seconded the motion,

Mr. VEARES, expressed regret at the disappointing account given by the chairman of their position; and the report of the directors he regarded as one of the most gloomy documents that had ever emanated from any Board.

Mr. WILLIAM ABBOTT congratulated the shareholders upon the fact that, at any rate, they were now in possession of a repairing ship, so that they would get rid of a great number of difficulties which had heretofore hung over them. Reference was made in the report to the efforts which had been made to obtain some subsidy from the British Government, and he hoped that the Board would make a further application to the present Government, which was sailing under the flag of Liberalism. "Liberal principles" was the cry of Her Majesty's Government, and he hoped the directors would take an early opportunity of waiting on the Government, and showing them that their principles might be extended to this Company.

Mr. JOHN NEWTON asked whether the Company's cables were in good order.

The CHAIRMAN, in reply, said that nothing further had been done with regard to the Central American connection, as there had been difficulties in the way which appeared insuperable. He did not think it would be any advantage to this Company to take steps in the matter, especially as the coming competition across the Atlantic—which reduced the cost of messages to 6d. per word —would not have a beneficial effect upon the traffic of this Company. The cables were in good working order. In further replying to Mr. M'Dermott, the chairman added that they had £22,500 of their reserve fund in cable in stock and other stores, and the other investments in respect of that fund stood at £14,217 on the 31st of December last. The report was then adopted.

On the motion of the CHAIRMAN, seconded by Mr. WILLIAM ANDREWS Mr. Henry Holmes was re-elected to his seat at the Board, reference being made to the special services rendered to the Company by Mr. Holmes in connection with the purchase of the new ship.

Subsequently on the motion of the CHAIRMAN, seconded by Sir JAMES ANDERSON, Mr. Henry Weaver was also re-elected a director.

Mr. VEARES then moved and Mr. C. J. LEE seconded the re-election of Mr. J. G. Griffiths as the auditor of the Company.

A vote of thanks to the chairman and directors terminated the proceedings.

SOCIETY OF TELEGRAPH ENGINEERS.

MAY 12, 1880.

Owing to the indisposition of Dr. Siemens the paper announced was postponed. The President, Mr. W. H. Preece, however, himself provided good fare for the members in a paper on the destruction by insects of gutta percha underground. He said that he was very grieved on Friday last to receive an intimation from Dr. Siemens, that owing to the advice of his doctor it was absolutely impossible for him to deliver the paper announced for that (Wednesday) evening on "Practical applications of the dynamo machine; and recent experiments in horticulture with the electric light." But Mr. Preece was glad to announce that Dr. Siemens would give the paper as soon as possible and, as the session was drawing to a close, a special night would be devoted to the purpose.

Mr. PREECE then said that the long promised Ronalds' catalogue was at last completed, and ready for distribution among subscribers, and that the library would shortly be open to the members of the Society, and also, under certain regulations, to the public.

The business announced for the evening was then commenced by the President making the following remarks on the "Behaviour of gutta percha when used for dielectric purposes." During the past few years a peculiar decay of gutta percha has been observed, the cause for which has been difficult to trace. Gutta percha is a gum exuded by a tree found in the India archæpelago, and is a compound of carbon and hydrogen containing about 88 per cent. of the former, and 12 per cent. of the latter. It never exists in a pure state, and although processes of purification are gone through, it has not yet been found possible to produce a percha which is not subject to a more or less speedy decay. Gutta percha is isomeric, or identical in its chemical construction with oil of turpentine and such compounds; and though so well known to electricians, it is really a child amongst the materials applied in the arts. Dr. Siemens happened to be present at the Society of Arts some 38 years ago when a specimen of gutta percha was produced before that Society, and it occurred to him that such a material was commercially valuable. Faraday pronounced it as possessing good electrical qualities, and so the material was adapted, and since then it has been used for telegraphic purposes. Gutta percha is soluble in olive oil, benzine, &c. On the contrary it is attacked by ozone, creosote, &c. It is also susceptible to and combines with oxygen, and undergoes the ordinary rusting process in air, especially when subjected to the influence of light. In process of manufacture water is absorbed, and in variations of temperature this water evaporates, causing the residuary gum to crack, and become brittle. This brittleness induced Mr. Edwin Clark to cover gutta percha wire with a wrapping of tape which had been saturated with tar. But as tar contains creosote, in attempting to prevent or replace the evaporation of water, another evil was introduced. Gutta percha wires, which were extensively laid in 1852-3-4, speedily decayed, and Mr. Eyken attributed this decay to growth of fungus. But recently such supposition had been entirely upset. It was noticed that underground wires principally failed at the joint boxes, and careful examination with the aid of a microscope proved that in all such cases of decay the presence of a small white insect could be detected. Sir John Lubbock was invited to inspect a joint box one day, and immediately recognised the insect as the templetonia crystallina.

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This minute, transparent animal possesses a great taste for gutta percha. (An enlarged drawing of the insect was exhibited, and several specimens on microscopic slides were available for inspection.) Wherever these animals are present gutta percha decays, and there is no doubt that their presence is the cause, though from their minuteness it is almost impossible to prove the fact. If joint boxes be hermetically sealed, gutta percha is preserved; but to prevent the action of insects the best cure is to cover the percha with lead, through which they will have to make their way before reaching the material for which they evidently have a special liking.

Mr. D. BROOKS, of Philadelphia, remarked that in America gutta percha covered wire was rarely used except in crossing rivers.

Mr. TRUEMAN suggested that pure gutta percha was less likely to be attacked by insects than impure gutta percha. He also afterwards spoke of oxidation as the great enemy to the durability of gutta percha, and hinted that a plan had been devised to obviate such oxidation, but that at the present time he was unable to describe the system.

Mr. LATIMER CLARK recognised the form of decay in the gutta percha exhibited by the President, and concurred with him that it was due to insect action. The great question, however, relative to the durability of gutta percha, was that of oxidation, and it was to this the speaker directed the attention of the members of the Society. Mr. F. Webb used a covering of lead or zinc, others used tape plain or painted, the latter, however, seemed to increase the oxidation instead of to diminish it. In connection with the cable stations in the East a plan had been followed which had proved perfectly successful. Previous to the introduction of this plan faults were of constant occurrence. The plan (introduced as the President explained by Mr. L. Clark) was the use of iron tubes kept filled with water, through which the connection between the cable and station was drawn.

Mr. FLEETWOOD stated that it was generally thought that "joints" were the bugbears in underground working, but in three years not ten faults had in London occurred through joints. The great difficulty against which they had to contend was oxidation. Joints had ceased to be inconvenient since the use of "Chatterton's compound" had been abandoned. When gutta percha covered wires are completely buried, and especially in clay, their durability seems almost perfect.

Mr. BELL corroborated the remarks of Mr. Fleetwood.

Professor AYRTON stated that in Germany they were using a trough filled with cement in order to obviate oxidation.

Mr. BROOKS, at the request of the President, explained his system of insulation. He said that he had been experimenting for twenty years, frequently to find on application at the Patent Office that he had been forestalled. He had tried resin, pitch, and various hydrocarbons, but found all defective. He at length determined on paraffin, but for a long time his efforts to get permanent insulation were not successful. Moisture would penetrate and create faults. At length, by employing pure oil under pressure, he succeeded, and now he insulates his wires in pure paraffin under constant pressure. The moisture is therefore unable to penetrate inwards, because of the pressure of the oil outwards. (Specimens of wire thus insulated were shown).

The PRESIDENT replied to the various observations, expressing pleasure in having elicited so good a discussion.

Mr. KEMPE then described an electric speed indicator, and

Mr. WILLMOT described certain improvements in Wheatstone's automatic receiver.

(It is impossible to describe these instruments without illustrations.)

THE HALL AUTOMATIC ELECTRIC RAILROAD SIGNALS.*

The "block system" has been generally acknowledged by competent authorities as the safest system for working railroad signals and conducting traffic. Notwithstanding this fact, it is used to only a very limited extent on even our busiest railroads.

If we inquire into the reason for this, we shall find that it is largely due to the imperfection of most of the appliances which are used in operating this system, and that they do not completely eliminate errors and thus make it practically infallible. Late improvements in these appliances—such as the apparatus of Messrs. Saxby and Farmer, known as the "union of the block and interlocking systems" and the "electro-semaphores" used on some of the French railroads, have contributed greatly toward perfection, and thus, it is thought, should have overcome the objection to the introduction of the block system.

There is, however, still another and probably even stronger objection, which is purely economical. New appliances require an outlay of capital; and the cost of maintaining and operating them would swell considerably the working expenses of a railroad. It is this last expense to which the managers of our roads are mostly averse. In Europe the great number of watchmen employed on railroads—as, for instance, in France, in connection with electro-semaphores—are advantageously used to attend to the signals also; but the small number of *employés* of this class on our roads would make it necessary to engage new men for this work.

We will not discuss here whether this extra expense would be repaid in the end, but attention will be called to the efforts of American inventors to annul this obstacle in the progress of the system by devising such appliances as will act automatically without the intervention of attendants.

Such automatic signals, invented by Mr. Thos. S. Hall, are already in operation on some of the New England railroads. They combine the block with the interlocking system, and have been worked out with remarkable inventive skill.

The manner in which they are operated being different from that of other signals purporting to have the same object, it needs to be understood before the mechanism of the apparatus can be clearly comprehended. Each line is divided into sections, at the entrance of which are erected two signals, one called the "danger signal," and the other the "safety signal." These signals are of the disc form, visible when displayed through circular openings made in boxes in which they are enclosed. They are placed on posts of sufficient height to be conspicuous. The "danger signal" is placed immediately at the entrance to a section, and the "safety signal" some 1,000 feet further. The disc of the first is red, and that of the second is blue; but this difference is not essential to the system, and both of them can be of the same colour. From the difference in names of the two signals, it should not be concluded that the one when displayed means *danger*, while the other when displayed means *safety*, as either of them in this position is the signal of danger, and thus stops the advance of a train. The name of "safety signal" was given to the one because it gives the means of a constant control of the working order of the apparatus, which must be observed by the locomotive driver. Any derangement of the signals, being thus easily discovered by the first train passing, would be reported at the nearest station—the train having passed over the section cautiously—and the damage could be speedily repaired.

The signals are acted on by electric currents, being connected by wires with a battery. At all times, when one of the two signals is displayed, the other is hidden from view—the change of the position of one of the signals causing the reversal of the other. The way in which this is effected will be described below.

An examination of the system will show that the signals, say, at C and D on the "up line," and at M and N on the "down line," have their "danger signals" hidden, and the "safety signals" displayed. This position of the signals indicates that the corresponding sections are not occupied, and that trains may therefore run over them. The signals at B have just the reverse position, in consequence of the section B C being occupied by a train. If a train on the section A B were now to arrive at B, it would find that the "danger signal"—which is the first which would be seen—was displayed, and thus the section B C would be blocked. But the first train, which then occupies the section B C, arriving at C, finds the "danger signal" hidden from view; it therefore advances and enters the section C D. At the moment when the train enters this new section, the following action occurs: The "danger signal" at C displays itself, and the change of its position causes a change of position of the "safety signal." The train arriving next in sight of the "safety signal," and finding it hidden from view, does not stop, but proceeds further. This position of the "safety signal" indicates to the engineman that the "danger signal" behind him has been displayed to protect his train. Should he, however, find the "safety signal" displayed on his approach to it, he would know that something was wrong with the apparatus, and would proceed cautiously over this section, reporting the derangement at the nearest station.

This reversal of the signals is effected by means of an electric current, closed by the action of a wheel of the passing train which depresses a lever of a "track-instrument." This track-instrument is placed in close proximity to the "danger-signal." Although the train has entered the section C D the section B C remains still closed by the undisturbed position of the signals at B, and it is not until the train reaches a second track-instrument, which is placed about 1,600 feet from C, that a circuit acting on the signals at B reverses their position, and thus opens the section B C for traffic.

It will be noted here that the train is already well protected by the signals from the rear, when the section behind is opened for a succeeding train.

* Abstracted from the *American Railroad Gazette*.

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The same operation continues along the whole line as the train proceeds from section to section.

Hall's signals can easily be applied to a depôt which possesses several switches, side and cross-over tracks, and a roadway crossing. On either track, about a mile each way from the station, is seen a track instrument marked "Strikes bell at road crossing." A train passing over one of these instruments closes a circuit which strikes an electric bell at the watchman's house at the road crossing, notifying the watchman of the approach of a train, and he then closes the roadway against ordinary traffic. The use of the locomotive steam whistle is thus replaced by an electric bell. The approach to the depôt is protected by two distant signals, the "danger" and the "safety signals," in exactly the same manner as the entrance to a block section on the open road, as described above. But, it being advisable that the station agent and the passengers be notified in time of the approach of a train, the reversal of the signals from *safety* to *danger* causes an electric bell, placed at the station, to strike. Each line has a separate bell. These bells, being of distinctive tones, indicate also the directions from which the trains approach. This is another instance of the suppression of the use of the steam whistle.

The track instruments which open the way to the depôt are, placed at the other extremities of the depôt, as shown in the plan.

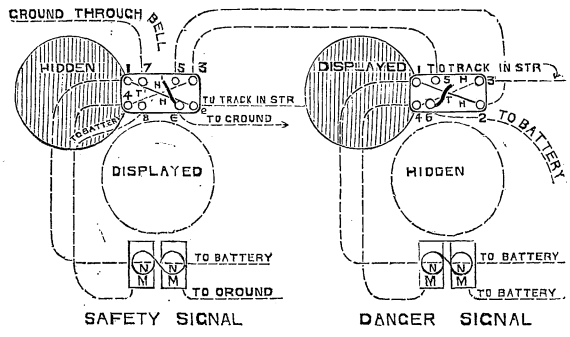
To enable the station agent to operate the distant signals from the station—the necessity of which may sometimes arise, as, for instance, when the passengers are crossing the "up line" to take the "down line" train, in which case the "up line" should be closed—a hand instrument is placed there, with which the signals can be set either at *danger* or *safety*. The instrument is locked, and the key of it is in the possession of the agent.

The switches are interlocked with the distant signals, by means of "switch instruments," in such manner that whenever a switch is set wrong to one of the main lines, the respective signals will display *danger*—if they were not previously in that position—and remain so, unaffected either by the track or the hand instrument, until the switch is set back for the main line, when the signals will be set automatically to safety. Should a switch be placed at a long distance behind the station, in order not to prevent a train from approaching the station, a special switch signal, operated by the instrument of this distant switch, may be erected.

The diagram shows the connection of wires of the two signals, "safety" and "danger," which constitute one signal post. The disc of the "danger" signal is shown displayed, while the disc of the "safety" signal is hidden (both being, however, in the raised position). Such position of the signals indicates that the section of the road which is guarded by them, is occupied by a train. The signals remain in this position until the train passes over a track instrument.

Every track instrument connects the "ground wire" with the signal apparatus; but that track instrument which *opens* a section connects with the "safety signal" apparatus—namely, with its connector, 2 (see Fig. 1), and that track instrument which *closes* a section connects with the "danger signal" apparatus—namely, with its connector.

FIG. 1.



If, therefore, in the position of signals shown in the diagram, the train passes over a track instrument that *opens* a section, an electric current is closed which runs from the ground through the track instrument, the safety signal—namely, its connector 2, circuit-closer H, connector 1, electro-magnet N N, and hence through the battery to the ground again, or *vice versâ*. (The connection of wires is indicated in the diagram with dotted lines.) As the electro-magnet, N N, becomes magnetised, it produces a fall of the "safety signal" discs which will then take the displayed position shown in dotted lines. At the same time the circuit-closer, H, will swing, or switch off, from the position indicated by a full line into the position H′, shown by a broken line, which change of position will break the circuit between the connectors 2 and 1, destroying the vitality of the electro-magnet N N. The action of the electro-magnet is thus momentary, and as soon as the stroke of one wheel of a train on the "track instrument" has produced the change, all subsequent strokes are without effect; hence, that portion of the apparatus which contains the circuit-closer H has been called by the inventor the "cut-out." At the same time that this is accomplished, the spring circuit-closer, T, of the "safety-signal," by the action of a finger, P, closes another current, which runs from the ground through connector 6, the circuit-closer T, connector 5, to the danger signal, namely, through its connector 2, circuit-closer H, connector 1, to the electro-magnet N N, and thence through the battery to the ground again, or *vice versâ*. This circuit causes the fall of the disc of the "danger" signal, in which position it is hidden. The circuit-closer H of the "danger" signal will then take the position shown by the dotted line, breaking the circuit, but producing no other effect. The position of both the signals will thus be reversed and the section will be opened for traffic. If a train should now enter upon this section, the track instrument which *closes* the section would be struck by the wheel, and cause a current to pass from the ground through the track instrument to the "danger signal," namely, through its connector 3, the circuit-closer in the position H′, connector 4, to the electro-magnet M M, and thence through the battery to the ground again, or *vice versâ*. This would cause the disc of the danger-signal to rise again in the displayed position, and the circuit-closer to take the position shown at H. As soon as this is accomplished the spring-circuit-closer T of the "danger signal" would close momentarily, completing a circuit that passes from the battery through connector 6, circuit-closer T, connector 5, to the connector 3 of the "safety signal," then through its circuit-closer in the position H′ to connector 4, then to the electro-magnet M M, and thence through the ground to the battery again. The disc of the "safety" signal will rise, therefore, into its hidden position. The section of the road will thus be closed again for traffic until the operation described at first is repeated.

If the signals belong to a depôt section, the apparatus of the safety signal is provided with another spring circuit-closer, T′, which, when the disc rises, is closed and completes a circuit passing from battery through connector 8, circuit-closer T′, connector 7, and thence through a bell (placed at the station) and the ground to the battery again, or *vice versâ*. Thus the approach of a train is announced at the station. In this manner the signals are operated by the movements of the trains themselves.

The switch interlocking instrument consists of a lever, L, pivoted at P P in a casting, G, the lower portion of which is shown broken off, but which resembles the casting of the track instrument, and is likewise bolted to a cross-tie of the road. The lower end of the lever is connected with the switch-rails by a rod in such manner that when the switch is being moved the lever L swings on its pivot, taking a position indicated by the centre lines *l l* or *l′ l′*, Fig. 2. While the switch is set for the main line the lever L has the vertical position, as shown in the engraving. The upper end of the lever is provided with two cams, *b* and *b′* (Fig. 2). The casting G has on its top a cover, C, on which are attached two insulating wooden blocks, A and B, carrying six metallic plates with connectors, marked 1 to 6. Three spring circuit-closers, *a*, *c*, *e*, serve to effect closures, or a breaking-off of the electric currents between the connectors; the circuit-closer *a*, between connectors 1 and 2, the circuit-closer *c*, between connectors 3 and 4, and the circuit-closer *e*, between connectors 5 and 6. They are operated by means of the following mechanism, and in the following manner:—

FIG. 2.

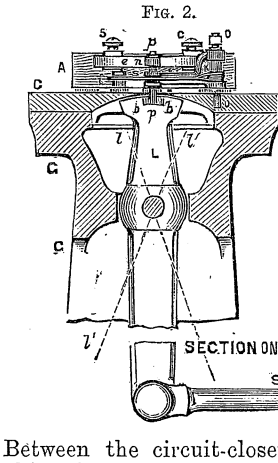
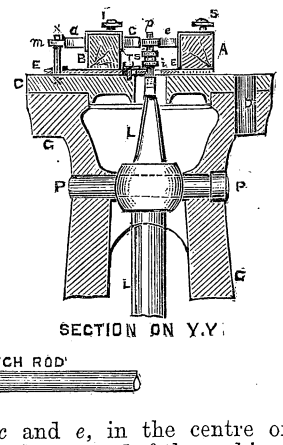


FIG. 3



Between the circuit-closers *c* and *e*, in the centre of the machine, is a pin, *p*, which is held by one end of the rocking-arm, *k*, the other end of which is pivoted by a stud, *o*, around which

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the arm with the pin *p* can swing in the horizontal plane. The pin *p* carries at its upper end an insulated button, *n*, which, pressing on one of the circuit-closers, *c* or *e*, will establish electric communication between the respective connectors. Around the stud *o* is wound a spring wire, *s*, in such a manner that both its ends are carried straight, one on each side of the rocking-arm *k*, to a stud, *z*, fixed on the cover, which holds the ends of the said spring in the normal position if no outside force separates them from each other. The tendency and object of this spring is to lead the rocking-arm *k* and the pin *p* to the normal central position.

The circuit-closer *a* is operated by means of an insulated button, *m*, attached to a stud, *x*, which is fastened to a sliding plate, E. This plate is held in position by means of a washer and a screw, as shown at *r*, Fig. 3, a slot in the plate E, through which the screw passes, admits of a motion to the plate in the direction of its length. The plate E takes the motion from the pin *p* which passes through it, as shown in the sectional views; but there is also a longitudinal slot, *i* (Fig. 3) which enables the pin *p* to accomplish some motions without moving with it the plate E. In one position of the plate the button *m* presses on the circuit-closer *a*, which is then closed. This is one fixed position of the plate E, the other fixed position being when the circuit-closer *a* is released from the pressure of the button *m*. It being important that the plate E should not move from its fixed positions by the action of any accidental cause, a projection, *v*, is made in the edge of the plate, which bears against a fixed stud, *w*, being held thus by the tension of a small spiral spring, *q*. When the plate E is to be moved, sufficient power must be applied to force the projection to pass to the other side of the stud *w*.

The pin *p* is moved by one of the cams *b* or *b'* of the lever L, when the switch is being moved and the lever consequently changes its position from the vertical to one of the diagonals, shown at *l l*, or *l' l'* (Fig. 2). Suppose that this action take place, and that the lever L swings to the position *l l*. Let us then consider the relative changes of position which will take place between the cams and the pin *p*. The normal position is that in which the pin *p* is between the cams *b*, *b'*; but as the lever is moved the cam *b* comes in contact with the pin, forces it to one side, and when the lever L completes the swing, the pin *p* passes to the other end of the cam *b*. The pin *p* then returns to the centre line of the cams by the action of the spring *s*. The switch is now set for the siding. In the return movement, the cam *b* is moved in the opposite direction, forces the pin to the other side, and at the completion of its movement the pin takes again the central position. The switch is then set back for the main line.

The object of the second cam *b* is to provide the same action on the pin *p*, if the switch has three throws. The pin *p* will make movements identical with those just described, whether one or the other of the cams acts upon it.

Before describing the various effects of this operation, it remains to be said that the circuit-closer *a* is interposed in the wire which connects the signals with that track instrument which sets them in the safety position, or opens the block section. If this circuit-closer *a* is closed, an electric current—when closed by the said track instrument—will pass through the connector 1, circuit-closer *a*, connector 2, to the signals; but when the circuit-closer *a* is opened, the track instrument will have no effect on the signals, as the connection is broken. The second circuit-closer *c* of the switch instrument closes a circuit which acts on the signals, setting them in the *danger* position—closing the block section—while the third circuit-closer *e* closes a circuit which sets the signals back to the *safety* position.

The operation will now be easily understood.

When the switch is set for the main line, the circuit-closer *a* is closed, establishing the communication between the track instrument and the signals, which can thus be operated by the passing train. In the description of a depôt application, it is indicated that the hand instrument at the station cannot act on the signals if the switch is set wrong to main line; this is effected by interposing the same circuit-closer *a* of the switch instrument in the wire connecting the hand instrument with the signals.

When the switch is being moved, the pin *p* is momentarily forced on one side of the cam *b*, and breaks the communication between the track instrument and the signals by opening the circuit-closer *a*—the pin *p* having moved the slide E and with it the button *m* to the position shown; it closes the circuit-closer *c*, thus setting the signals at danger and closing the main line against trains. At the completion of the movement of the switch to the siding, the pin *p* is released from the action of the cam; and the pin by the action of the spring *s* (which has been previously forced into position) is moved back to the centre line—the slot *i* in the side E admitting this movement without being itself affected by it; all the three circuit-closers are then opened. It should be remembered that the signals are now set at danger by the momentary closure of the circuit-closer *c* during the intermediate position, and that no track or hand instrument can reverse them, in consequence of the position of the circuit-closer *a*.

When the switch is being moved back to the main line, the pin *p* is forced to the other side of the cam *b*, and the circuit-closer *e* is closed, effecting the reversal of the signals from the danger to the safety position; the circuit-closer *a* is also closed, establishing the, until now broken, communication between the track instrument and the signals, in consequence of the movement of the slide E. As soon as the return movement is completed, the pin *p* is released, and returns to the central position, leaving, however, the slide E unaffected by this, in consequence of the slot, and the whole apparatus takes the position already described.

It remains to be added that, by a wrong manipulation, the signals may be so set as not to be in accordance with the position of the switch, but contrary to it. That is, the switch may be moved half way from the main line to the siding, or *vice versâ*, and then be moved back before it accomplishes full stroke. In the first case, the signals will be set at danger and be left in that position, although the switch is set back for main line; in the second case, a worse thing will happen, as the signals may be set to safety, while the switch is set back for the siding. To overcome this fault of the apparatus—which, however, could have effect only through the malice of a switch-tender—the lever with which a switch is operated can be attached to a special switch-stand, so arranged as to make it necessary that a switch be moved its full throw before it can be reversed.

In the same way as a switch is interlocked with the signals, the lock of a drawbridge is made to control them.

Finally, it remains to be added that still another improvement has been added by Mr. Hall to the *guarding of railroad crossings*, namely, a continuous electric bell is made to ring at such places of danger, from the time the train is half a mile or some desired distance from the crossing until it has passed it. This is effected by placing two "track instruments" at the points between which the train is to be signalled; the first of them causes the electric bell to ring, and the second stops its action. Thus a continuous signal, audible all the time that the crossing is in danger, not only keeps control over the watchman, but also, in case of his absence, sudden illness, or neglect, will of itself warn persons attempting to cross the track of the danger.

THE FIRE AT MESSRS. SAMUEL BROTHERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We must ask you to correct a statement in *The Electrician* of May 8th respecting the cause of the fire at Messrs. Samuel Bros., Ludgate-hill.

It could not possibly have been due, as you state, "to an escape of gas from a gas engine, which supplies the electric light." The engine ceased running at eight p.m. on the evening in question, and the gas was turned off at that hour, at the special meter provided for the engine, the gas in the supply-pipe being exhausted at the same time. As the fire did not break out till about eleven p.m., or three hours afterwards, it could not have been due to an escape of gas from the source you mention, nor is there a particle of evidence to show that the fire was in any way connected with the electric light or apparatus for working it.—Your obedient servants,

CROSSLEY BROS.

116, Queen Victoria-street, London,
May 13th, 1880.

NEW PATENTS, 1880.

1397. ELECTRIC LAMPS.—*(A communication).—C. D. Abel.*
1405. ELECTRIC CONDUCTORS.—*O. Heaviside.*
1475. TELEGRAPHIC CABLES.—*F. Wirth (Frankfurt).*
1507. ELECTRIC LAMPS.—*G. G. Andre.*
1510. TELEGRAPH INSULATORS.—*G. Wells and A. Gilbert.*

ABSTRACT OF PATENTS.

3259. TIME INDICATORS, *M. T. Neale.—Dated 13th August*, 1879. 6*d*.

This consists in the application of the arrangement of a relay to a time indicator, such as a magnet deflected by electricity passing through coils, or an ordinary delicate coil and armature or spring relay for the purpose of closing a local circuit in time indicators, in conjunction with a local battery cell or cells, which may be or may not be concealed in the time indicator, which said local circuit is for the sole purpose of actuating its own set of hands.

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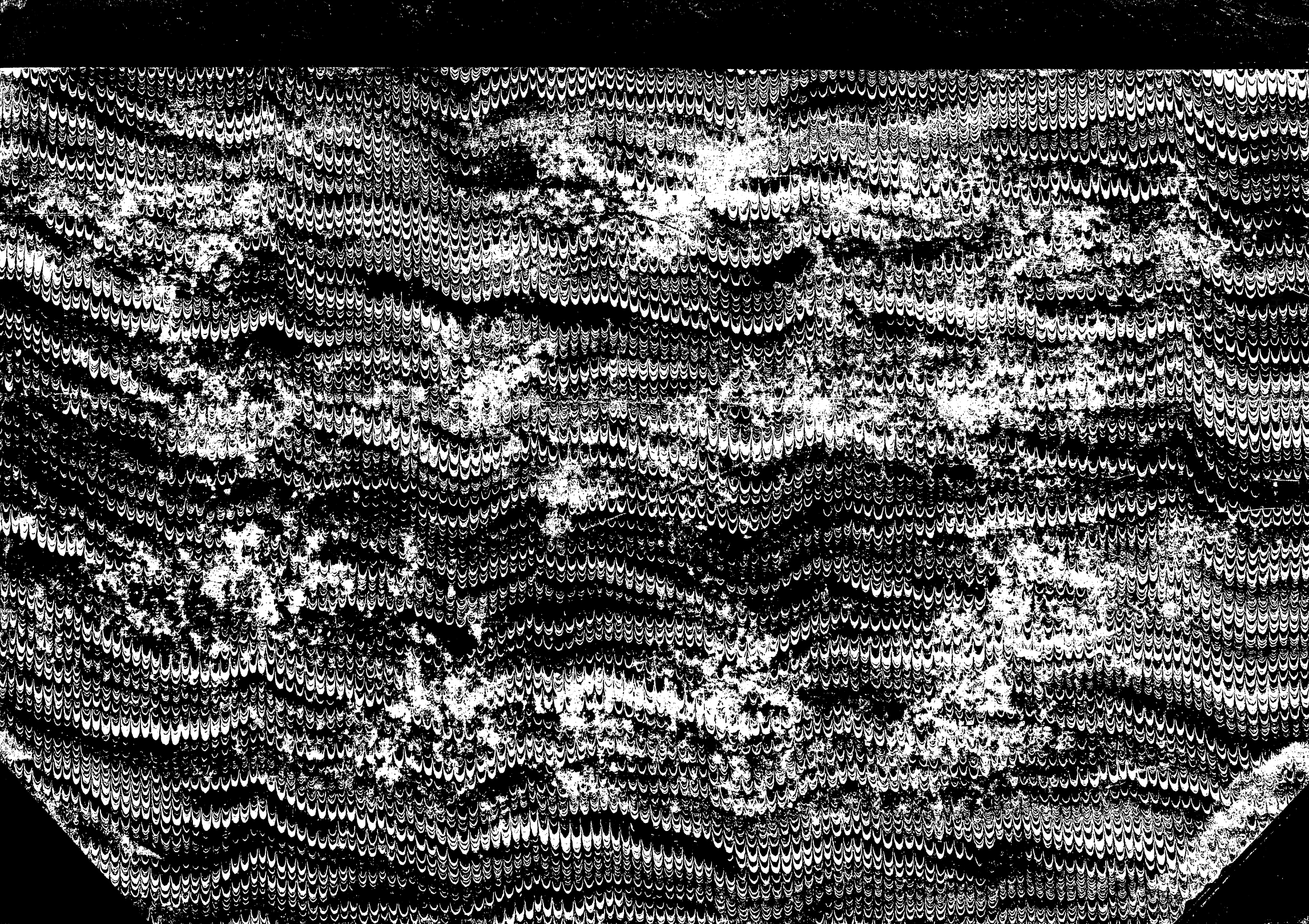
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